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Related to the Silicate Industries

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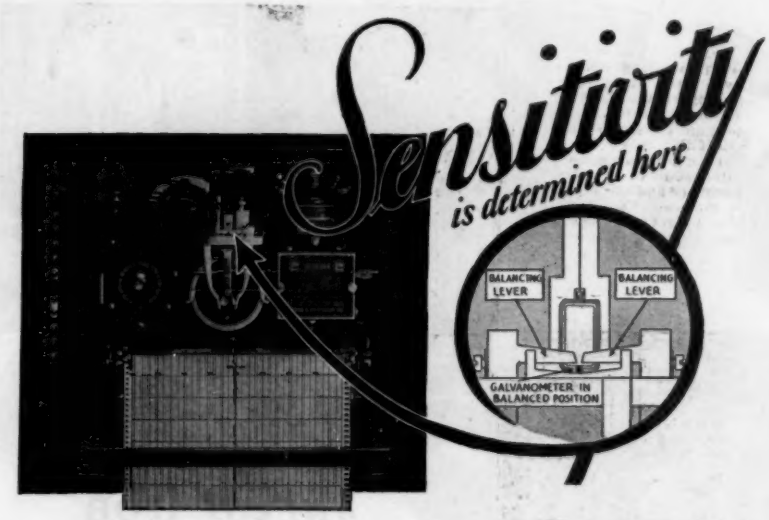

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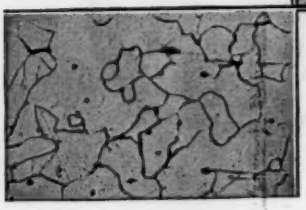

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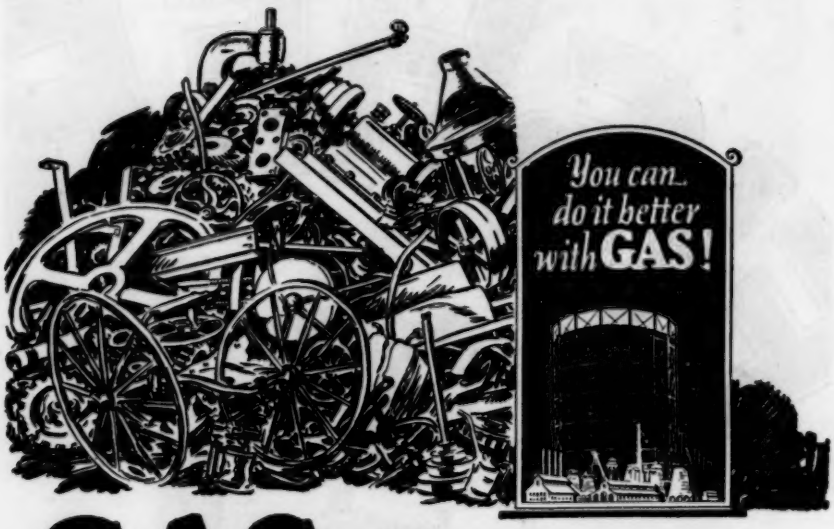

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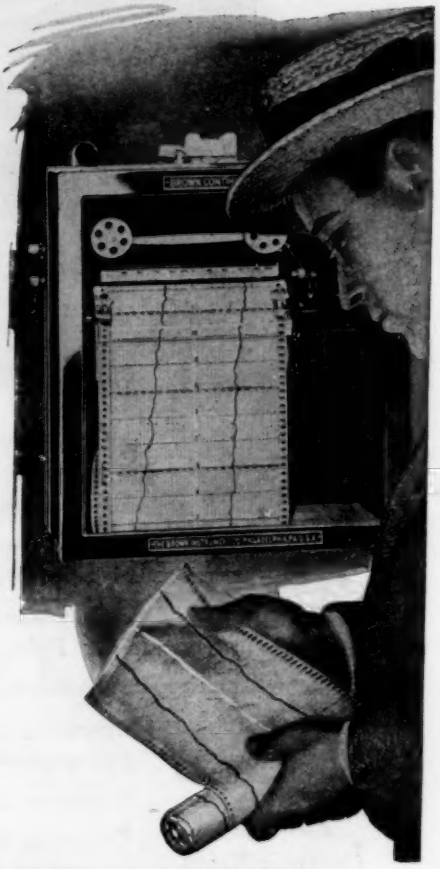

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THE RATE OF OXIDATION OF PORCELAIN AND BALL CLAYS[1]

By Hobart M. Kraner and E. H. Fritz

ABSTRACT

In this study the rate of CO_2 evolution was determined by passing a 4% oxygen to 96% nitrogen gas mixture over a bar of clay or porcelain while this bar was being heated at an approximate rate obtained in the ceramic kilns. The water and CO_2 evolved were collected in phosphorous pentoxide and soda lime, respectively, and the respective apparatus weighed each half hour during the length of the run. It was found that oxidation took place rapidly between 200°C and 550°C in both clay and porcelain. This is much different from what has been generally understood to be true, for in all the ceramic literature 750°C seems to be indicated as the most efficient temperature at which oxidation proceeds. It appears that oxidation of ceramic ware such as these can take place at much lower temperatures and with much greater economy in firing practice.

Introduction

Most of our information regarding the oxidation characteristics of clays and bodies has been obtained by noting the effects upon test pieces by exposing them to oxidizing atmospheres at 750°C for definite periods of time. This is an effective means of obtaining some information regarding these clays or bodies, but unfortunately it affords us no fundamental information from which generalizations might be drawn. The method is probably also responsible to a certain extent for our somewhat varied ideas regarding the oxidation period for the ware.

Riddle[2] establishes a firing schedule in which oxidation conditions are maintained up to cone 09 (approximately 950°C). Wilson, in his book, Ceramics in Clay Technology, gives 350 to 960°C as the oxidation range of clays. Jackson,[3] shows that the carbonaceous material is removed from a fire clay in 4 hours at 460°C, in $2^3/_4$ hours at 600°C, and in 2 hours at 675°C. Stull[4] gives 450 to 950°C as the oxidation temperature of clays. Green[5] states that oxidation starts near 480°C but progresses most rapidly at about 650°C, depending upon the clay. Searle[6] states that oxidation takes place most rapidly at 800 to 900°C and commences at much lower temperatures.

There seems to be a general agreement in the above but the information is not very definite and does not give one an idea of the rate at which the process goes on as a piece of ware is heated in the kiln; neither does this information give specific information regarding the rates of oxidation of the various ball clays in which the whiteware manufacturer may be interested.

---

[1] Received Oct. 22, 1928.

[2] *Jour. Amer. Ceram. Soc.*, **1** [9], 626 (1918).

[3] *Ibid.*, **7** [2], 168 (1924).

[4] Ohio Geol. Surv., *Bull.*, No. 26.

[5] *Jour. Amer. Ceram. Soc.*, **8** [9], 599 (1925).

[6] Chemistry and Physics of Clays and Other Ceramic Materials, p. 491.

With the faster firing schedules obtained in tunnel kilns, more definite information regarding oxidation is vital. The following investigation was therefore taken up in the laboratory, imitating the early portion of the firing schedule for an electrical porcelain body containing approximately 25% each of ball clay, china clay, flint, and feldspar.

Procedure

A bar of unfired porcelain or clay was heated in the furnace at a rate similar to that followed in the firing of the ware. At the same time, a substantially water- and CO_2-free gas was passed around the bar at a rate approximating the atmospheric change in the kiln. The water released was absorbed by P_2O_5, and the CO_2 resulting from the oxidation of the organic matter was absorbed by damp soda lime. (See Fig. 1.)

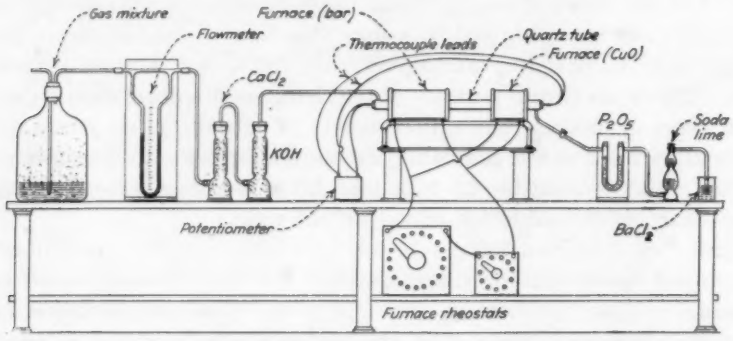

FIG. 1.—Set-up of test apparatus. Determination of rate of CO_2 and water evolution with dry gas.

The bar was made from clay ball milled to pass 100-mesh. This was dried on plaster to molding consistency.

In order to imitate kiln conditions as nearly as possible, the temperature rise, the atmosphere, and the rate of atmospheric change were considered. The atmosphere was 96% nitrogen and 4% oxygen and this was passed around the $^9/_{16}$ by $^9/_{16}$ by $5^1/_2$-inch bar at 150 cc. per minute. This was considered similar to a fairly oxidizing kiln atmosphere. The atmospheric change during oxidation in a periodic kiln fired with natural gas is approximately 50 times per hour. It was found necessary to use 150 cc. of the gas (300 changes per hour) in this set-up in order to carry the water directly to the absorption train without condensation in the cooler portions of the apparatus. The temperature of the bar was raised at the rate of 25°C per hour and was measured by a thermocouple at each end of the bar.

The gas mixture was dried and freed of CO_2 before passing through the

furnace. Granular calcium chloride and fused KOH sticks were used to dry the gas. KOH removed the CO_2 as well. As a drying agent, KOH is more convenient and practically as efficient as P_2O_5. The moisture in the gas not removed by KOH in a 32-hour run at 150 cc. per minute amounts to only 0.00057 g. and its accumulative effect could not affect the shape of the curve obtained.

At the lower temperatures, CO may be a product of heating the bar of clay under such conditions. In order to convert any such CO to CO_2, a roll of copper gauze heated by a separate furnace was included in the train shown in Fig. 1.

The bar was dried at 110°C, cooled in a desiccator over calcium chloride, and then sealed into the tube of the furnace. The temperature of the bar was then raised at the rate of 15°C and 25°C per hour as indicated on the

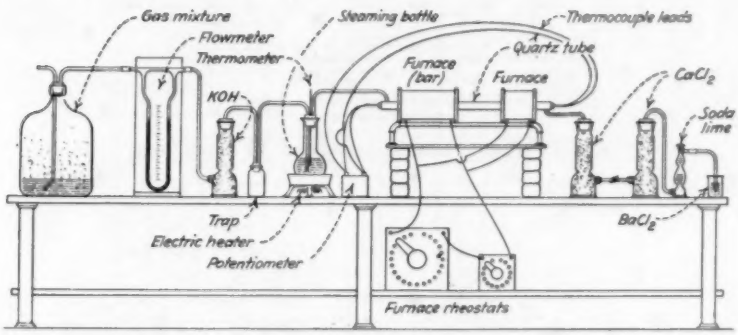

FIG. 2.—Set-up of test apparatus. Determination of rate of CO_2 evolution using wet gas.

curves. The water and CO_2 were collected as stated above and weighed every half hour by means of a double absorption train connected by a two-way stop-cock. After the completion of the run, the bar was cooled in the furnace to black heat with the system closed and then in a desiccator over calcium chloride. It was weighed as rapidly as possible. Even by rapid weighing it was found difficult to weigh accurately due to the apparent tendency of the bar in this condition to absorb moisture from the atmosphere.

The results of this work are plainly indicated by the accompanying curves. The upper right hand curve of each group of four showing the amount of CO_2 or water evolved *vs.* time, together with the temperature curve, is the data curve. From this, the other three of the group of four were made. This development was considered necessary to show the effect of temperature alone as well as to eliminate the effect of variation of the bar sizes, although the sizes were kept as nearly the same as was practical. The curves, time *vs.* percentage of total, and temperature

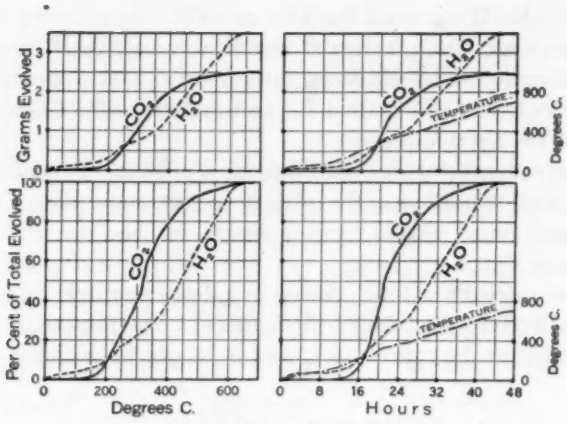

FIG. 3.—Plastic process porcelain; 15°C per hour.

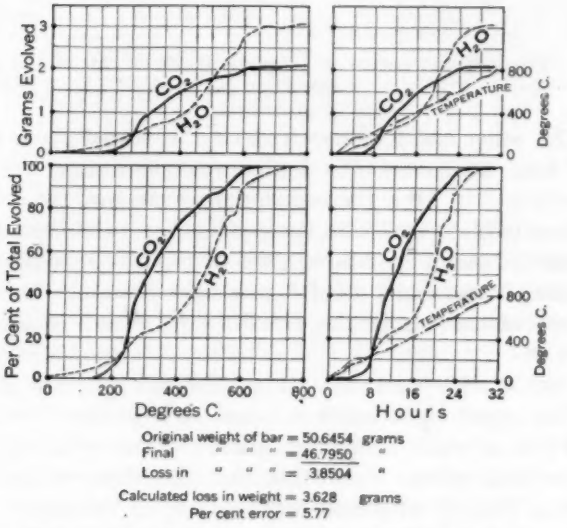

FIG 4 —Plastic process porcelain; 25°C per hour.

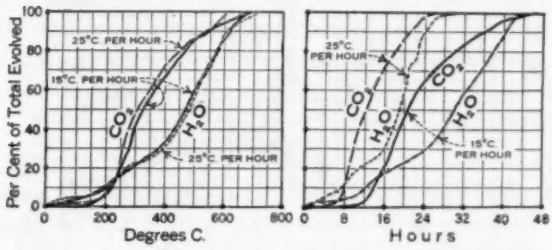

FIG. 5.—Oxidation of porcelain; 15 and 25°C per hour.

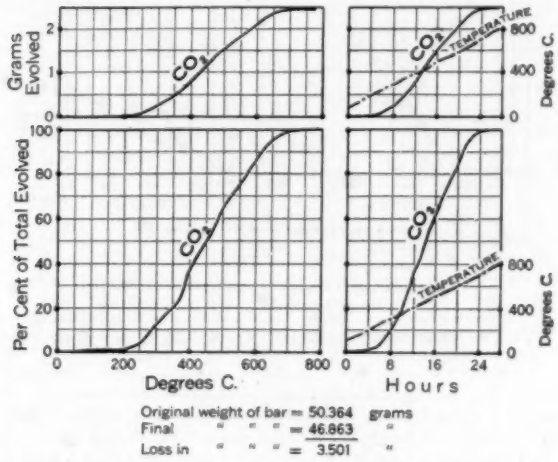

FIG. 6.—Plastic process porcelain. Gas saturated with H_2O at 90°C; 25°C per hour.

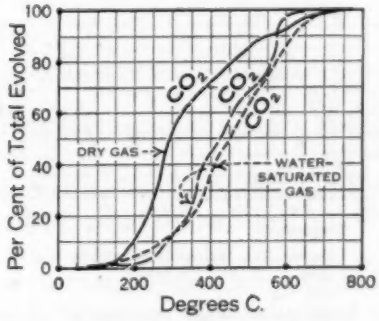

FIG. 7.—Oxidation of porcelain in dry and wet atmospheres.

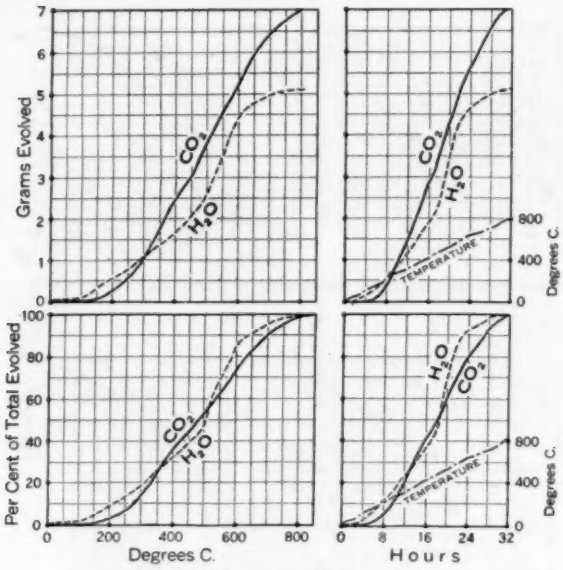

FIG. 8.—Kentucky ball clay No. 4; 25°C per hour.

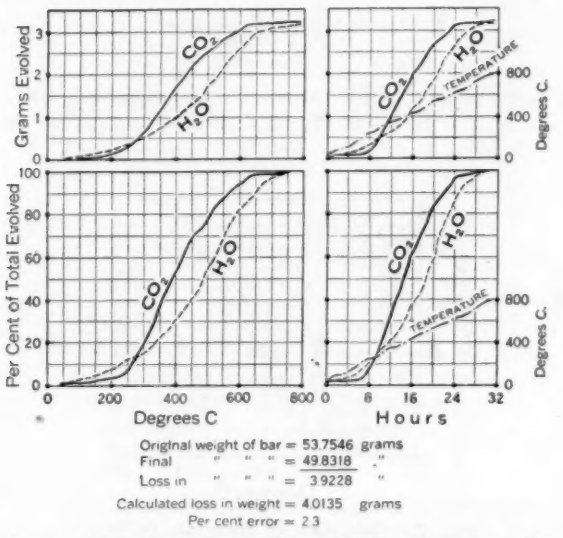

FIG. 9.—Kentucky ball clay No. 4 (50%) and potter's flint (50%); 25°C per hour.

vs. percentage of total, will permit a direct comparison of oxidation rates. The original curves (weight *vs.* temperature or time) will give an idea of the relative quantities of material evolved, *i.e.*, the relative carbon and water contents of the clays or body.

Oxidation of Porcelain

Curves showing the rate of oxidation of porcelain body were obtained by heating the bar at 25°C and 15°C per hour. These were plotted as shown

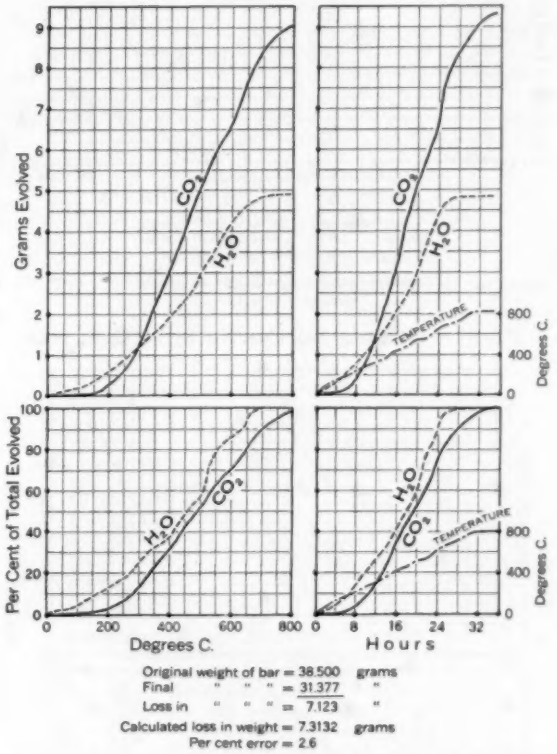

FIG. 10.—Kentucky dark special ball clay; 25°C per hour.

in the curves following and indicate plainly that under these conditions the oxidation was largely a function of temperature. This, of course, may not be true with other atmospheric conditions.

In order to study the effect of excessive humidity at low temperatures in the kiln, a run was made by passing a gas saturated with water at 90°C through the absorption train while the bar was being heated at the usual rate (see set-up in Fig. 2). This gave a gas having a fairly high relative

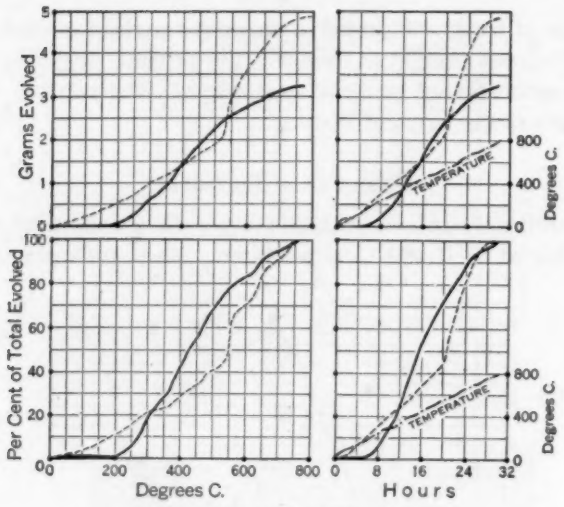
Grams Evolved
Per Cent of Total Evolved
TEMPERATURE
Degrees C.
Degrees C.
Hours
Original weight of bar = 44.4055 grams
Final " " " = 38.8459 "
Loss in " " " = 5.5596 "
Calculated loss in weight = 5.6649 grams
Per cent error = 1.9

FIG. 11.—Kentucky ball clay No. 8; 25°C per hour.

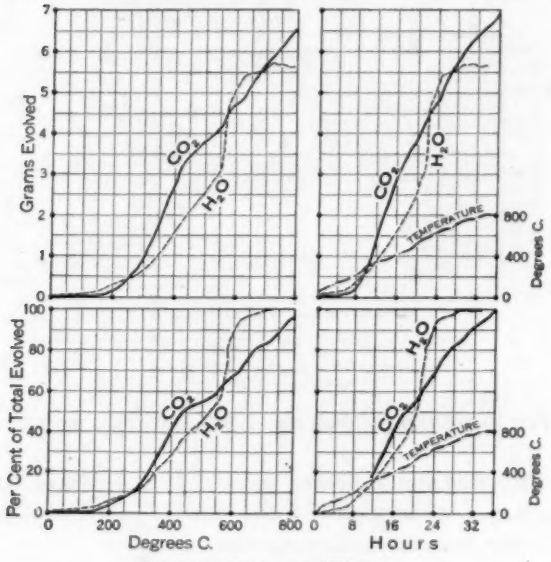

FIG. 12.—M&M English ball clay; 25°C per hour.

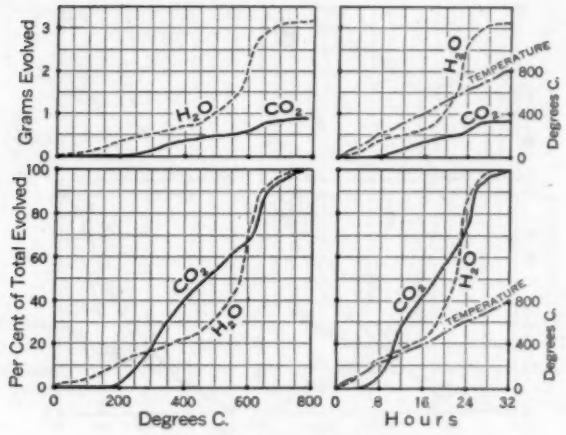
Grams Evolved
Per Cent of Total Evolved
Degrees C.
Hours
TEMPERATURE
Original weight of bar = 48.6040 grams
Final " " " = 45.0446 "
Loss in " " " = 3.5594 "
Calculated loss in weight = 3.3277 grams
Per cent error = 6.5

FIG. 13.—M&M ivory fat ball clay; 25°C per hour.

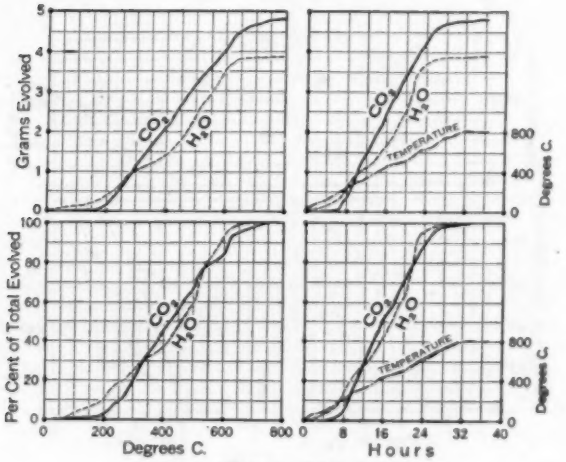
Grams Evolved
Per Cent of Total Evolved
Degrees C.
Hours
TEMPERATURE
Original weight of bar = 42.643 grams
Final " " " = 37.776 "
Loss in " " " = 4.867 "
Calculated loss in weight = 5.1919 grams
Per cent error = 6.6

FIG. 14.—M&M paragon ball clay; 25°C per hour.

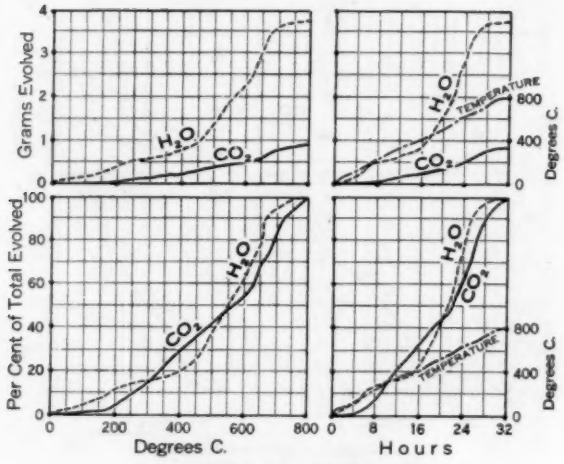
Grams Evolved
Per Cent of Total Evolved
Degrees C.
Hours
TEMPERATURE
Original weight of bar = 45.8698 grams
Final " " " = 41.4870 "
Loss in " " " = 4.3828 "
Calculated loss in weight = 4.0136 grams
Per cent error = 8.3

FIG. 15.—Dorset English ball clay; 25°C per hour.

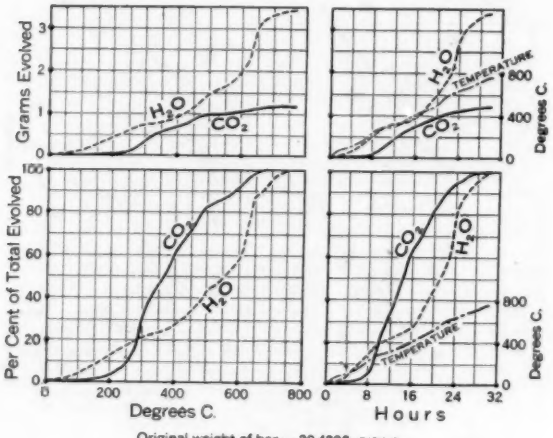
Grams Evolved
Per Cent of Total Evolved
Degrees C.
Hours
TEMPERATURE
Original weight of bar = 39.4306 grams
Final " " " = 35.4578 "
Loss in " " " = 3.9728 "
Calculated loss in weight = 3.7801 grams
Per cent error = 4.8

FIG. 16.—English ball clay No. 25; 25°C per hour.

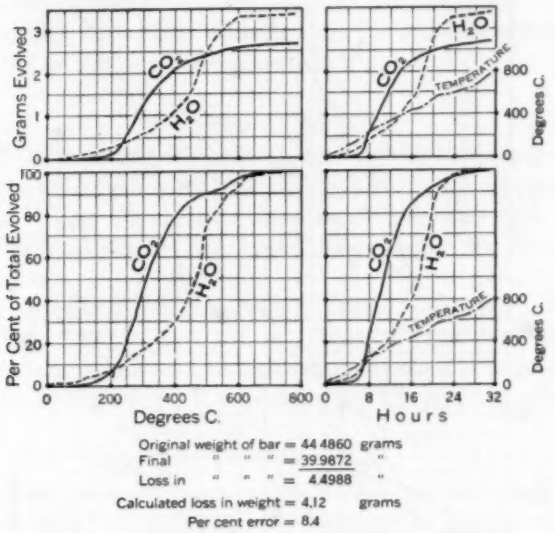

FIG. 17.—Jernigan ball clay; 25°C per hour.

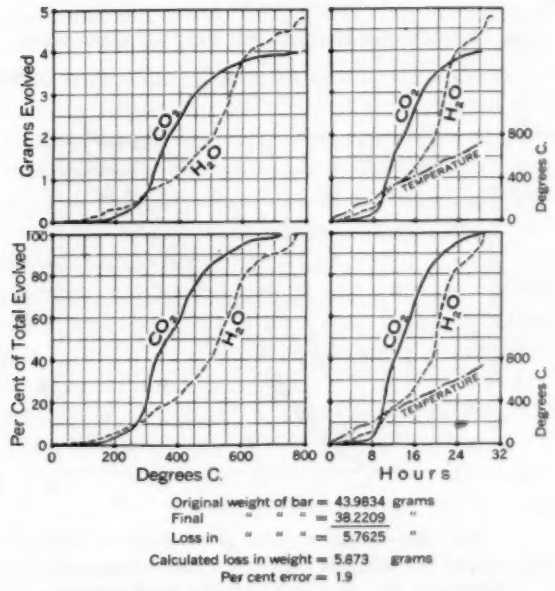

FIG. 18.—Tennessee ball clay No. 5; 25°C per hour.

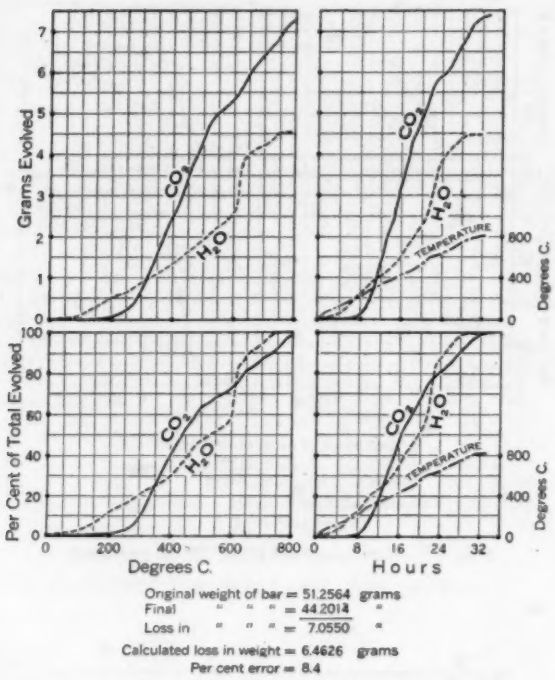

FIG. 19.—Missouri Hercules ball clay; 25°C per hour.

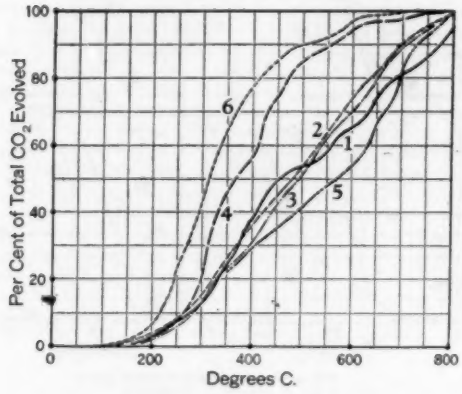

FIG. 20.—Relative rates of oxidation of ball clays: (1) M&M English ball clay; (2) Kentucky No. 4; (3) Kentucky Dark Special; (4) Tennessee No. 5; (5) Dorset; (6) Jernigan.

humidity at low temperatures, probably as high as might be obtained in practice from the combustion of natural gas or removal of water from the ware. Results of this work are shown in Fig. 6.

Oxidation of Ball Clays

In view of the fact that 25°C heating and 15°C heating seemed to give similar results and that oxidation took place rapidly enough to permit heating at 25°C per hour under these conditions, this rate was used in studying oxidation rates in ball clays. Accordingly, the following curves were obtained.

All of the ball clays oxidized readily except the M&M English, the Kentucky Dark Special, and No. 4. Bars of the first showed large black centers and those of the last showed small black centers, and these must be remembered while interpreting the corresponding curves.

Conclusions

(1) Oxidation proceeds more rapidly at low temperatures in porcelain and ball clays than has been generally considered, and this low temperature oxidation may be used to advantage in effecting or maintaining economical kiln firing. This may be done by maintaining thoroughly oxidizing conditions up to 650°C rather than to provide "an oxidation period." The heat lost by outgoing kiln gases up to 650°C in a maintained oxidizing condition of this kind is less than would be the case were oxidizing conditions maintained at higher temperatures where the rate of fuel consumption is greater. In the latter case the volume of the products of combustion is so great as to cause the heat loss to mount up considerably.

(2) The temperature at which oxidation may be completed is lower than it has been generally thought to be. In this work we have shown that porcelain or a ball clay-flint body may be completely oxidized at 600 to 650°C and a close grained ball clay may be 90% oxidized at 650° and completely oxidized at 700 to 800°C.

(3) The progress of oxidation seems to be almost entirely dependent upon temperature, and the effect of time may be important only in thick-sectioned pieces. Oxidation difficulties obtained in practice may be due to lack of circulation within saggers, etc.

(4) The percentage of carbon in a clay may not be a criterion of its probable rate of oxidation, especially in low carbon clays. Compare the English with the Tennessee clays. These differences may be due to grain size of the clay and organic material or to the composition of the organic material.

(5) Oxidation seems to proceed more rapidly in a dry atmosphere.

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SOME ASPECTS OF PLASTICITY AND RELATED PROPERTIES OF CLAYS[1]

By D. R. Irving and W. F. Dietrich[2]

ABSTRACT

This paper presents the results of Talwalkar-Parmelee plasticity measurements of a number of clays, and an interpretation of the results in the light of data on dye adsorption, water of plasticity, drying and firing shrinkage, and dry transverse strength. The clays studied are mainly from California, but tests of a few more widely-known clays from other sources are included for the purposes of correlation. Some data are given to show the effect of the addition of fine sand on the plasticity of a clay. The effect of variations in the water of plasticity is also considered.

Introduction

The relation of plasticity to other properties has not yet been determined, because of the difficulty of devising a satisfactory method for measuring plasticity. The ideal method would give a numerical result and many investigators have attempted to obtain such data. The more important of these attempts (the so-called direct methods of measuring plasticity) are the Bingham-Green plastometer,[3] Stringer and Emory ball deformation test,[4] Emley plasticimeter,[5] Bischof's extrusion method,[6] Vicat needle or similar apparatus,[7] Grout's compression test,[8] Zschokke's extension method,[9] and the Talwalkar-Parmelee torsion method.[10]

Regardless of the method that may be used to measure plasticity, it is apparent that the numerical evaluation of plasticity cannot be expressed as a linear function of a single variable.

The direct methods, to be adequate, must take into consideration the magnitude of the force applied (stress), the extent of deformation (strain), and the duration of the force. Any one of these factors may be held con-

[1] Received July 31, 1928.

[2] The main portion of this paper is taken from a thesis by D. R. Irving, presented as a partial requirement for the degree of Engineer in the Division of Ceramics, Dept. of Mining and Metallurgy, Stanford University. The thesis was done under the direction of W. F. Dietrich. Other parts of the paper, particularly the attempt to correlate plasticity with other properties of clays, are contributed by Mr. Dietrich.

[3] E. C. Bingham and Henry Green, *Proc. A.S.T.M.*, **19,** 641 (1919).

[4] J. W. Mellor, "On the Plasticity of Clays," *Trans. Ceram. Soc.* [Eng.], **21,** 93–94 (1921–22).

[5] W. E. Emley, "An Instrument for Measuring Plasticity," *Trans. Amer. Ceram. Soc.*, **19,** 526 (1917).

[6] Bischof, Die feuerfesten Thane, p. 84.

[7] A. B. Searle, Chemistry and Physics of Clays and Other Ceramic Materials, p. 280, Benn Brothers (1924).

[8] F. F. Grout, *W. Va. Geol. Surv.*, **3,** 40 (1905).

[9] B. Zschokke, *Tonind. Ztg.*, **29** [120], 1658 (1905).

[10] T. W. Talwalkar and C. W. Parmelee, "Measurement of Plasticity," *Jour. Amer. Ceram. Soc.*, **10,** 670 (1927).

stant or may be varied independently, but the other two then become dependent variables, and the relation between them is not linear throughout the entire range of values that must be studied. In particular, it is one of the characteristics of clay pastes that stress is proportional to strain up to a certain limit (usually known as the "yield point" or the "proportionality limit") beyond which a relatively small stress will produce continuous deformation until rupture occurs. Since the yield point is a measure of the ability of the plastic clay to retain its shape during drying and since the amount of deformation before rupture is a measure of its moldability, it can be seen that the entire curve of stress *vs.* strain must be used in order to permit a proper interpretation of the data of plasticity. The equation of this curve often takes the general form:

$$y = \frac{x}{a + bx}$$

in which y is the unit stress and x is the unit strain, but may take other and more complex forms. Thus far, neither the form of the equation nor the numerical value of the constants therein has been found to obey any general law that connects plasticity with other physical properties of clays.

That there may be certain systematic relations between plasticity and other properties has been suggested by many investigators and is implied in a number of the proposed indirect methods of measuring plasticity. Some of these are as follows:[11] tempering water, drying shrinkage, water adsorption, strength, viscosity of clay suspensions, and colloidal content.

Plasticity Tests

Torsional After a search of the literature and a few experiments, the Talwalkar-Parmelee[10] method was adopted. In this method, a plastic clay bar is subjected to torsional stresses and the curve showing the stress-strain relations up to the point of rupture is used as a measure of plasticity.

If stresses are plotted as ordinates, and the corresponding angular strains as abscissas, the height of the curve above the x-axis is a measure of the strength (or yield-point), *i.e.*, ability to withstand deformation. The length of the curve, and especially its upper terminal value (*i.e.*, its right-hand limit) is a measure of the moldability of the clay, or in other words, the amount of deformation it will withstand without rupture.

For the purpose of ready comparison, it is convenient to plot only that part of the stress-strain curves above the proportionality limit. The resultant curve is a straight line connecting the proportionality limit with the point of failure. Because they appear to include all of the relevant data of the plasticity test, these plots may be spoken of as plasticity index

[11] Hewitt Wilson, Ceramics, p. 107.

lines. In final analysis, it may be found that the essential criteria of plasticity, as measured by the apparatus, are the values of stress and strain at the point of rupture, but it does not yet seem advisable to entirely exclude the proportionality limit from consideration.

The machine as built in the ceramic laboratory at Stanford University is essentially the same as that described by Talwalkar and Parmelee, and the same practice was followed in the preparation of the samples and the molding of test specimens.

In its present form, the procedure of making the tests is open to a number of objections. The manner in which the load increments are added to the pan may introduce an error; if the weight pan swings, the results will be affected. There are three variables, inherent in the apparatus itself, contributing to the results obtained by this method: the load on the pan, the angular deformation at the point of failure, and the duration of the test. But in the present investigation, as well as in that by Talwalkar and Parmelee, the time factor has been made to depend upon fortuitous circumstances. In order to permit study of this factor, and at the same time to eliminate the constant attention required by the apparatus in its present form, an automatic apparatus has been designed, and will be built whenever these studies are continued. The automatic apparatus will not only shorten the manipulative time required for a test, but will shorten the total elapsed time, and will give a more accurate end-point.

Dye Adsorption It is thought by many investigators that the most useful method of estimating the relative amount of colloids in a clay is by means of the measurement of the amount of an organic dye adsorbed by a definite quantity of clay. It has been shown, however, that different colloids have different adsorptive powers. Since several different types of colloids in varying proportions may be present in clays, dye adsorption is not a reliable method of estimating even the total percentage of colloids present. When applied to a series of clays of similar type and geologic origin, but varying in the percentage of inert matter present (*e.g.*, fine sand) the method may have some value. In the present investigation, both methylene blue and malachite green were used. James W. McBain[12] of Stanford University suggested the use of methylene blue. Most investigators have used malachite green,[13] which is open to the objection that calcium salts, if present, affect the results.

The method of determining the amount of malachite green adsorbed was as follows:

[12] Personal communication.

[13] H. E. Ashley, "Technical Control of Colloidal Matter of Clays," U. S. Bur. Stand., *Tech. Paper*, No. 23 (1913).

One gram of clay, previously ground to pass 60-mesh and dried at 110°C, was added to 50 cc. of a malachite green solution containing 6 g. of the dye per liter of distilled water. The mixture was agitated on a mechanical shaker for two hours, and allowed to settle overnight. In the case of slow-settling material, a centrifuge was used.

On the following day, 0.5 cc. of the standard dye solution was placed in one of a pair of 50-cc. color comparator tubes. The standard was diluted to at least 35 cc., as accurate color comparisons cannot be made if a more concentrated solution is used. Into the other tube, 1 cc. of the supernatant liquid of the clay test was placed, and the colors of the solutions in the two tubes were matched by diluting the darker. If the required dilution exceeded 50 cc., the test was completed by diluting an aliquot part of the original solution.

The same procedure was followed in the case of adsorption of methylene blue, except that the strength of the standard dye solution was 0.5 g. per liter. Also, 10 cc. of the test solution was compared with 1 cc. of the standard. It now seems that a strength of 1 g. per liter would have been better.

Drying and Firing Data

The drying and firing data were obtained by the methods recommended by the Society[14] with certain modifications,[15] the most important of which was the use of a 14-hour firing cycle to cone 13 rather than the recommended minimum cycle of 24 hours.

Experimental Schedule

Determinations of plasticity, drying and firing phenomena, and percentage dye adsorption are available for fifteen different clays, a key to which is given in Table I.

Several series of plasticity tests were made to study the effect of variations in the water content and of different periods of aging. The clays included in these series were Samples 96, 146, 276, 302, and 303. The results of these tests confirm and supplement the results presented by Talwalkar and Parmelee.[10]

The effect of fine quartz upon the plasticity of clay Sample 146 was studied.[16] One series was prepared by adding minus 200- plus 325-mesh quartz in 10% increments from 0 to 50% of quartz. In another series, minus 325- plus 490-mesh quartz was used in 12.5% increments from 50

[14] Report of the Committee on Standards, *Yearbook*, 1921–22. For revised standards, see *Jour. Amer. Ceram. Soc.*, **11** [6], 448–57 (1928).

[15] Described in full in "Clay Resources and the Ceramic Industry of California," by W. F. Dietrich, Calif. Div. of Mines and Mining, *Bull.*, No. 99, pp. 238–53 (1928).

[16] Laboratory work for these tests was done by D. C. Linton and W. W. Meyer, graduate students in ceramics at Stanford University, under the direction of the authors.

TABLE I

KEY TO CLAY SAMPLES INVESTIGATED

(Samples from California sources, except Nos. 276, 302, and 303)

Sample No.	Designation	Summary of properties
15*	Main tunnel fire clay from Alberhill	White-firing, refractory not vitrifying below cone 15
61*	Surface clay from Santa Monica	Red-firing, short vitrification range
96*	No. 10 clay from Alberhill	White-firing, refractory, vitrifying between cones 10 and 15
134*	Fire-sand from Ione (Clark pit)	White-firing, refractory, very sandy
146*	Nos. 1–6 clay from Lincoln	Buff-firing, refractory, vitrifying below cone 10
147*	No. 7 clay from Lincoln	Similar to 146, darker in color
148*	No. 8 clay from Lincoln	Red-firing, long vitrification range
210*	Dredge silt from Natoma	Red-firing, long vitrification range
276	English china clay	White-firing, nonplastic, open-firing
295**	No. 0 clay from Lincoln	Dark buff-firing, refractory, open-firing
296**	No. 9 clay from Lincoln	Buff-firing, refractory, vitrifying between cones 10 and 15
297**	No. 10 clay from Lincoln	Similar to No. 296
298	No. 11 clay from Lincoln	Similar to No. 296, but with higher dry strength
302	Kentucky ball clay (Mayfield)	White-firing, vitrifying between cones 5 and 10
303	English black ball clay	White-firing, vitrifying between cones 5 and 10

* Described in Calif. Div. of Mines and Mining, *Bull.*, No. 99, by W. F. Dietrich.
** Earlier samples of these clays described in same *Bulletin*.

to 87.5% of quartz. The sand was sized by elutriation in an apparatus similar to that of Schultz.[17] Previous investigations[10] have been made with relatively coarse sand.

Results of Plasticity Measurements

Plasticity vs. Water Content

The plastic No. 10 ball clay from Alberhill (Sample 96), the Nos. 1–6 plastic fire clay from Lincoln (Sample 146), the English china clay (Sample 276), and the Kentucky (Sample 302) and English (Sample 303) ball clays were each tested after two days' aging at three different water contents, ranging approximately from the upper to the lower limit of plasticity. In addition,

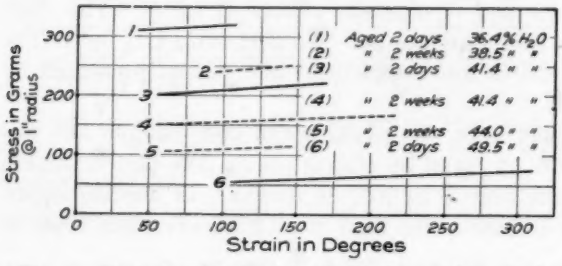

Fig. 1.—Variations in plasticity index lines of Lincoln fire clay (No. 146) with variations in per cent water of plasticity and in aging period.

[17] J. F. Krehbiel, "Experiments with Fine Grinding of Flint and Spar," *Trans. Amer. Ceram. Soc.*, **6**, 186 (1904).

Samples 96 and 146 were tested at three different water contents after two weeks' aging. The results of these tests are summarized in Table II, and some of the typical plasticity index lines are shown on Fig. 1.

TABLE II
EFFECT OF VARIATIONS IN WATER CONTENT AND AGING ON PLASTICITY

Sample No.	Aging period (days)	Per cent water	Plasticity test data: Proportionality limit Stress (grams)	Proportionality limit Strain (degrees)	Point of failure Stress (grams)	Point of failure Strain (degrees)
96	2	25.8	390	68	400	123
		29.6	185	86	200	205
		34.0	85	141	90	241
	14	25.65	410	53	420	118
		28.6	180	60	190	190
		35.8	65	74	75	282
146	2	36.4	310	41	320	109
		41.4	200	54	220	170
		49.5	65	212	75	309
	14	38.5	240	94	250	142
		41.4	150	54	165	217
		44.0	105	60	115	151
276	2	33.15	450	37	460	59
		35.4	300	38	310	70
		38.3	180	41	190	105
	14	36.0	230	39	250	79
302	2	45.15	170	75	185	305
		47.4	110	68	120	290
		55.4	75	80	85	400
303	2	50.3	190	210	200	345
		53.5	150	143	160	336
		55.85	115	167	125	450

In all of these tests it was found that the load required to produce rupture decreased with an increase in the water content of the clay. In a number of cases, the relation between breaking stress (l) and percentage of water present (w) can be approximately expressed by the equation of the straight line, of the form $w = al + b$, in which the constant a is negative, and b is positive. For example, the following equations fit the data within a maximum error of 2%, for the range of water contents investigated:

Sample 146, 2 days' aging: $w = 53.5 - 0.0535\,l$
" " 14 " " : $w = 48.4 - 0.0407\,l$
" 276, 2 " " : $w = 41.66 - 0.01925\,l$
" 303, 2 " " : $w = 65.2 - 0.074\,l$

From the data of Talwalkar and Parmelee,[18] the following equations were derived:

Johnson & Porter No. 10 ball clay: $w = 52.3 - 0.06\,l$
(neglecting the first run at 46.3% water content)
Idealized curves: $w = 60.9 - 0.0526\,l$

In a few cases, however, the relationship is expressed by the more

[18] *Loc. cit.*, pp. 676 and 682, and Fig. 6.

complex equation of the cubic hyperbola, of the type $w = al^b + c$, in which a is positive, b is negative, and c may be either positive or negative. As examples of this type of equation, the following are cited:

Sample 96, 2 days' aging: $w = 97.36\, l^{-0.09294} - 30$
" " 14 " " : $w = 547.3\, l^{-0.865} + 22.7$
" 302, 2 " " : $w = \left(\frac{l}{157.8}\right)^{-3.855} + 44.6$

The data thus far available indicate that the linear relationship is the one to be expected, and that serious deviations from the straight line may sometimes indicate that part of the data is faulty. In this connection it may be recalled that Talwalkar and Parmelee[19] have restated the discovery of Bingham[3] regarding the relation between pressure and mobility of solid-liquid mixtures as follows:

> The stress-strain relations of solid-liquid mixtures are similar to those of solids and the limit of proportionality varies directly as the solid phase, or inversely as the liquid content.

With respect to the change in final deformation with variation in water content, no generalizations can be ventured at present. In many cases the data verify the *a priori* prediction that the total deformation at the point of failure will increase with increase in the water content, but a distressingly large number of the tests showed no progressive relation between these factors. For example, the results on Sample 146 with 14 days' aging, on Samples 302 and 303, and on Johnson and Porter No. 10 ball clay as reported by Talwalkar and Parmelee,[20] all show that the total deformation is either greater or less at the middle water content of the series than at either the high or the low water content. In all other cases studied, the total deformation increased progressively with increase in the water contents, the relation being expressed by the general equation of the form: $w = ad^b + c$, in which w is the per cent of water in the clay, d is the

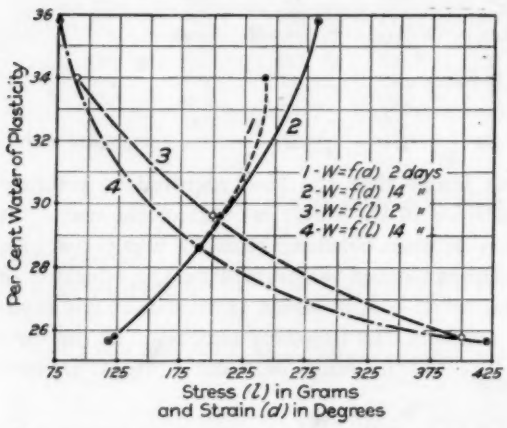

Fig. 2.—Per cent water of plasticity vs. stress and vs. strain. Alberhill No. 10 clay (Sample 96) aged for 2 days and 14 days.

[19] *Loc. cit.*, p. 673.
[20] *Loc. cit.*, p. 682 (Fig. 12).

deformation at the point of failure in degrees, a and b are positive constants, and c is a constant that may be either positive or negative. The following examples are cited to illustrate the wide variations that have been observed:

Sample 96, 2 days' aging: $w = \left(\frac{d}{150}\right)^{4.53} + 25.4$

" " 14 " " : $w = \left(\frac{d}{107.6}\right)^{2.54} + 24.4$

" 146, 2 " " : $w = 21.5\, d^{0.305} - 20$

As noted previously, the data on final deformation are difficult to obtain with the apparatus in its present form. It is probable that much of the eccentricity of the observed values was caused by errors of observation and that when the apparatus is refined and made automatic, these errors will be greatly lessened.

The data in Table II show that the proportionality limit is altered by variations in water content in much the same manner as is the case with the point of failure, and that the equations representing the water content as a function of stress and strain at the proportionality limit would be closely similar to the corresponding equations at the point of failure.

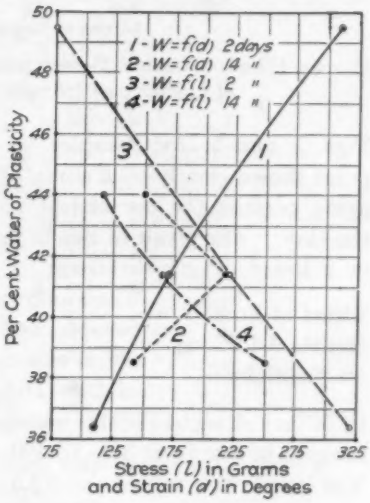

FIG. 3.—Per cent water of plasticity vs. stress and vs. strain. Lincoln clay Nos. 1–6 (Sample 146) aged for 2 days and 14 days.

The foregoing presentation of the equations connecting plasticity and water content is given with the idea of encouraging the search for basic laws that might prove of use in practice. It is fully realized that three points are insufficient to permit the exact derivation of the equation of a curve, and that in many other respects the data at present available are inadequate, yet even with the present knowledge of the subject, it is apparent that if a clay has been tested at two or three different water contents, an estimation of the nature of the plasticity index curve at some other water content could be made with a fair degree of accuracy, either by the analytical or by the graphical method. Such interpolations might be used to good advantage in helping to decide upon the proper water content required in a given clay mix in order that it shall have a certain strength and moldability.

Plasticity vs. Aging

The results of tests to determine the effect of aging on plasticity are given in Table II. In all cases studied it was found that aging for 14 days caused a decrease in the load required for rupture as compared to the corresponding results after two days' aging. The effect of aging on the total deformation was erratic, but a general tendency toward higher deformation with the longer aging was noted. The curves of water content *vs.* breaking load and *vs.* deformation at the point of rupture are given for both periods of aging on Figs. 2 and 3, for Samples 96 and 146, respectively. An important point shown clearly by a study of these curves is that for a given strength aging permits the use of less water without lowering the moldability of the clay. The result of this in practice is usually either a denser structure or a lower drying shrinkage.

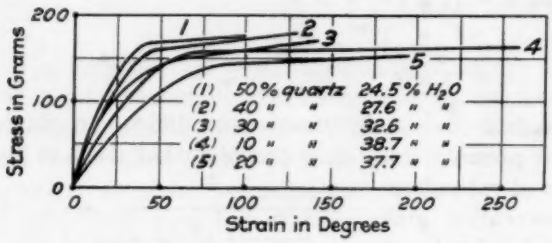

FIG. 4.—Effect of 200- to 325-mesh quartz on the plasticity of Lincoln clay (Sample 146).

Effect of Fine Quartz Additions on Plasticity

The following tests were made on mixtures of Sample 146 and finely crushed quartz. The first series was made by adding quartz, between the sizes of 200- and 325-mesh, in 10% increments from 10 to 50%. A second series was made with the same clay, but with quartz ranging in size from 325- to 490-mesh. The sand was added in 12.5% increments from 50 to 87.5% of sand.

The results of these tests are shown in Figs. 4 and 5. The data are not capable of accurate interpretation, because each test was made at but one water content. It can be seen however, that in the first series the differences in the loads required to produce failure in the several cases are slight, but there is a tendency toward increased strength with increased proportions of sand, up to 50%. With 10% and 20% quartz, the moldability is as good or better than that of the pure clay (see Fig. 1), at the same strength, but greater proportions of quartz rapidly decrease the moldability. The correlation of these results with those on the pure

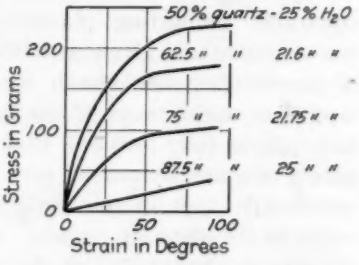

FIG. 5.—Effect of 325- to 490-mesh quartz on the plasticity of Lincoln clay (Sample 146).

clay can readily be made by interpolation from the curves of Fig. 1. For example, at 44.7% water, pure clay would give the same strength (165 g.) as the mixture with 10% quartz, but the deformation at the point of rupture would be 215° instead of 260°; at 44.1% water, pure clay would give the same strength (170 g.) as the mixture with 30% quartz, but the deformation would be 204° instead of 142°.

From the second series (Fig. 5) it is seen that the sample containing 50% of 325- to 490-mesh quartz showed a greater strength than the sample containing 50% of 200- to 325-mesh quartz. The water content was practically the same, as was the deformation at the point of failure. The greater strength as shown by the test confirms *a priori* reasoning from practice, but more complete data are needed before a definite law can be

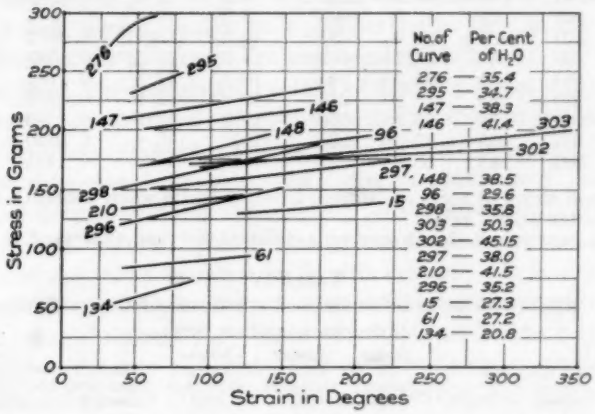

FIG. 6.—Plasticity index lines of various clays (see Table I for key) aged 2 days.

formulated. From the rest of the tests in this series, it is apparent that the plastic strength of the mixture is decreased rapidly by increase in the proportion of quartz beyond 50%, but that the deformation at the point of failure is but slightly affected.

The above conclusions regarding the effect of nonplastic additions on the plasticity of clay confirm and extend the conclusions of other writers. The further study of the effect of the addition of carefully graded sand of different sizes on the properties of clay offers a fertile field of research.

Plasticity vs. Other Properties of Various Clays

Figure 6 shows the plasticity index lines of the fifteen clays tested, at the optimum water content as estimated by feel, and after two days' aging. The data of the yield point are tabulated in Table III together with data on other properties of the same clays. To facilitate comparison,

the relative orders of the magnitude of the various properties are given in Table IV, which is arranged according to the order of plastic torsional strength. The clays will be discussed in groups, in the approximate order suggested by the table.

TABLE III

TEST DATA ON VARIOUS CLAYS

Sample No.	Plasticity[a] Stress (g.)	Plasticity[a] Strain (deg.)	Water of plasticity (%)	Dry transverse strength, (lbs./sq. in.)	Lin. drying shrinkage, (% dry length)	Lin. firing shrinkage, (% dry length)	Dye adsorption, g. dye per g. clay: Malachite green	Dye adsorption, g. dye per g. clay: Methylene blue
15	140	216	27.3	467	7.3	5.0	0.0675	0.0236
61	95	127	27.2	639	6.9	6.0	0.0755	0.0357
96	200	205	29.6	398	7.7	10.0	0.0741	0.0237
134	75	88	20.8	17	3.9	3.0	0.0440	0.0046
146	220	170	41.4	239	10.3	13.0	0.1016	0.0378
147	235	175	38.3	284	10.7	15.0	0.0936	0.0236
148	195	133	38.5	255	8.6	13.0	0.0682	0.0248
210	145	122	41.5	1009	12.0	10.0	0.1240	0.0427
276	310	70	35.4	(50)[b]	(5.0)[b]	(15.0)[b]	0.0372	0.0095
295	250	80	34.7	(447)[b]	(8.8)[b]	(10.5)[b]	0.1599	0.0527
296	150	150	35.2	245	10.7	12.4	0.1131	0.0224
297	160	280	38.0	254	10.8	12.9	0.1215	0.0234
298	190	175	35.8	558	11.1	12.6	0.1242	0.0236
302	185	305	45.15	186	11.1	16.4	0.1040	0.0235
303	200	345	50.3	275	11.3	17.3	0.1431	0.0405

[a] Stress and strain at point of rupture, all at optimum water content as determined by feel, and after 2 days' aging.

[b] Approximate values, determined on a different lot than that used in other tests.

TABLE IV

RELATIVE ORDER OF PHYSICAL PROPERTIES OF CLAYS TESTED

(Maximum magnitude first)

Sample No.	Plasticity: Stress	Plasticity: Strain	Water of plasticity (%)	Linear drying shrinkage (%)	Linear firing shrinkage (%)	Dry transverse strength	Dye adsorption: Methylene blue	Dye adsorption: Malachite green
276	1	15	9	14	4	14	14	15
295	2	14	11	9	10	5	1	1
147	3	7	6	6	3	7	9	9
146	4	8	4	8	5	12	4	8
303	5	1	1	2	1	8	3	2
96	6	5	12	11	12	6	7	11
148	7	10	5	10	6	9	6	12
298	8	6	8	4	8	3	10	3
302	9	2	2	3	2	13	11	7
297	10	3	7	5	7	10	12	5
296	11	9	10	7	9	11	13	6
210	12	12	3	1	1	1	2	4
15	13	4	13	12	14	4	8	13
61	14	11	14	13	13	2	5	10
134	15	13	15	15	15	15	15	14

English China Clay and Ione Sand

The plasticity of English china clay (Sample 276) is sticky and short, and the bonding strength is low. It is a finely divided material, but apparently contains a very low percentage of true colloidal matter. Of the clays tested, its physical properties are most closely related to those of Ione sand (Sample 134), the only important differences, insofar as the

numerical data revealed, being the diametrically opposed plastic torsional strengths and linear firing shrinkage, and the relatively less divergent differences in water of plasticity. By visual and tactual observations the two materials present striking contrasts. The Ione sand, containing approximately 80% of nonplastic mineral grains of a maximum size of 100-mesh, and 20% of plastic fire clay, has a sandy feel when mixed with tempering water. It tends to crumble when attempts are made to mold it into a desired shape. In short, it acts in every respect similar to a synthetic mixture of fine sand and plastic clay. This observation is verified by the fact that if the plasticity index line of a mixture of 80% quartz (325- to 490-mesh) and 20% of Lincoln clay is interpolated on Fig. 5, it coincides very closely to the observed plasticity index line of the Ione sand. Commercial practice in California has demonstrated that the clay portion of Ione sand is similar in its properties to the Lincoln clay. The two materials occur in beds of the same geologic horizon. By comparison with Ione sand, the nonplastic portion of English china clay, which may be present in approximately the same proportions as in the sand, is very much more finely divided. It has already been observed (see Figs. 4 and 5) that a decrease in the grain-size of the nonplastic portion of a mixture of clay and quartz tends to increase the plastic strength. It is probable that the greatly increased plastic strength of English china clay compared to Ione sand may be accounted for in this manner. It is also likely that the increased water of plasticity is attributable to the same cause. The increased firing shrinkage may be ascribed in part to the physical differences between the two materials, and in part to the increased alumina-silica ratio and greater combined water content of the china clay. The alumina-silica ratio of the china clay is approximately 1:1, that of the Ione sand is 1:3.75. The ignition loss, mainly due to combined water, is 12.5% for the china clay and 7.7% for the sand. These chemical differences, coupled with the differences in grain size, would tend to give the English clay a denser and more vitrified structure at ordinary firing temperatures, hence greater firing shrinkage, than would be possessed by the Ione sand.

The small drying shrinkage, dry transverse strength, and percentage dry adsorption of these clays are characteristic features of each.

High-Grade Lincoln Clays

The clays of this group, which are widely used in terra cotta, fire brick, stoneware, and tile manufacture on the Pacific Coast, have closely similar physical properties. Sample 148 fires red; the others fire light buff from cone 02 to 7 and light gray from cone 9 to 15. The total linear shrinkage of all varieties is nearly the same, and complete vitrification takes place in all cases at or below cone 12. Only in the vitrification temperatures and in the plasticity indices are there differences of such magnitude as to be of possible im-

portance in practice. In laboratory tests, Samples 146 and 147 vitrify at cone 7, 148 at cone 9, and 296, 297, and 298 at cone 12 (±). These differences in vitrification temperature correspond to the differences in plastic torsional strength. Thus, Samples 146 and 147 have greater plastic strength than 148, which is stronger than Samples 296, 297, and 298. The difference in plastic strength between Samples 148 and 298 is slight, which may be accounted for by the fact that Sample 298 was tested at a water content 10% lower than that at which Sample 148 was tested.

In the light of other data already discussed, the hypothesis seems warranted that Samples 146 and 147 contain a smaller proportion of nonplastic grains, probably of smaller average size, than Sample 148, and that 296, 297, and 298 contain a larger proportion of nonplastics, probably also of smaller average size, than 148. Further studies are planned to test the validity of this hypothesis.

Low-Grade Lincoln Clay (295) This is an impure variety, overlying the other Lincoln clays stratigraphically. Its properties differ widely from those of the other clays from this deposit. It is dark buff to red firing and does not vitrify completely at any temperature. It begins to bloat at cone 13, yet has a softening point of cones 28 to 29. Its principal uses are as an ingredient in sewer pipe and face brick mixes and to a limited extent in terra cotta and tile mixes. The plasticity is sticky and short, but long pugging and aging results in a marked improvement in plasticity, in the same manner as, but of greater degree than, the effect of similar treatment of a flint clay. In the tests herein reported, the clay was treated in the same manner as others that were tested and the full plasticity was not developed. Under these conditions the plasticity index line lies between that of English china clay, Sample 276, and of the Lincoln Sample 147, *i.e.*, the strength is high and the deformation is low. The water of plasticity is practically the same as that of English china clay, but in the results of all other tests, Sample 295 has a reversed order relative to 276. Perhaps the most striking difference, the significance of which has not been determined, is in the dye adsorption data. Sample 295 leads all other clays tested by a wide margin in the percentage of either dye adsorbed. Sample 276 has the lowest adsorption of malachite green and the second lowest adsorption of methylene blue of all the clays tested.

Alberhill No. 10 Clay This is a refractory clay with good plasticity that vitrifies to less than 5% apparent porosity at cone 15. It is extensively used in terra cotta and tile bodies. Its plasticity index line is intermediate between Samples 148 and 298. In the other properties studied, Sample 96 approximates Sample 148, but has a lower water of plasticity and a lower firing shrinkage. The decreased shrinkage might have been predicted from the lower water of

plasticity. The moldability, which is notably greater than that of Sample 148, is near that of Sample 298, and is less than that of Sample 297. The probable errors of the observations of plastic deformation are, however, so large that no special significance can be attached to these differences at present.

Kentucky and English Ball Clays

The superior plasticity of these well-known clays is indicated by a definitely high plastic deformation, coupled with medium plastic strength. Not only is the deformation at the point of rupture greater than that of any other clays tested, but the length of the plasticity index lines is greater. Samples 96 and 297 are the nearest competitors for high deformation, but the divergence between these and the two ball clays is too great to be accounted for by experimental errors, and it seems reasonable to credit the Talwalkar-Parmelee test with the ability of discriminating between the exceptional plasticity of high-grade ball clays and the moderate plasticity of typical fire clays and terra cotta clays. Other characteristic properties of the ball clays are the high water of plasticity and the high shrinkage, both in drying and in firing. Sample 303, which is slightly more plastic than 302, has a high adsorptive power for both of the dyes used, occupying second place with malachite green and third place with methylene blue, but Sample 302 occupies seventh place with malachite green and eleventh place with methylene blue. No properties of these clays as yet investigated give a clue to the reasons for this wide divergence in dye adsorptive power.

Alberhill Select Main Tunnel Clay

This is an open-firing plastic fire clay containing a considerable proportion of fine sand. It is more closely related, genetically and physically, to Sample 96 than to any other clay tested, as is shown by comparison of the waters of plasticity, and the drying and firing shrinkage. The plasticity index line of Sample 15 is in nearly the same position as would be expected if an appropriate amount of finely-divided nonplastic matter were added to Sample 96. If Sample 15 were tested with a lower water of plasticity, its plasticity index line would be expected to approximate that of Sample 148.

Santa Monica Surface Clay and Natoma Dredge Silt

These two red-firing clays were selected and tested for the purpose of initiating an investigation of the essential differences in the plastic properties of common clays in comparison to high-grade clays. Of the clays already discussed, only Sample 148 is typically red-firing; the others fire white or buff. It has been shown that the properties of Sample 148 do not differ materially from those of other Lincoln clays, save in firing color (and, of course, in refractoriness). This type has the smooth, strong plasticity of the ball clays, which is totally different from

the sticky plasticity of the clay portion of a typical surface clay suitable for brick manufacture. When the surface clays are mixed, by nature or artificially, with sufficient nonplastic matter to reduce their excessive stickiness, high shrinkage, and tendency to warp and crack during drying and firing, they have low plastic strength and are short, yet retain a stickiness and a short water of plasticity range that distinguishes them quite clearly from similar mixtures of a good ball or terra cotta clay with nonplastics. Such clays are highly desirable for use in the manufacture of face brick, sewer pipe, red earthenware, and of other products in the manufacture of which a smooth, strong plasticity or a fine, even texture is needed, coupled with suitable strength, shrinkage, and vitrification qualities. The usual methods of laboratory testing and the customary classifications of clays, even the elaborate classification of Parmelee and Schroyer,[21] do not adequately segregate these clays from the commoner varieties that are at best only suited for the manufacture of common brick and hollow tile, or may be used to but a limited extent as an ingredient in sewer pipe and similar mixes. Since the essential difference between these types seems to lie in the plasticity, it would seem that a test, such as that of Talwalkar and Parmelee, would aid in establishing the criteria for separate classification.

Samples 61 and 210 have low plastic strength and low deformability. The former clay might be definitely distinguished from the high-grade clays by means of the plasticity data, high dry transverse strength, and low water of plasticity. A high-grade clay with the addition of sufficient nonplastic matter to lower its plastic strength to that of Sample 61 would almost certainly have lower dry transverse strength and probably higher water of plasticity or higher deformability.

The classification of Sample 210 presents greater difficulties. It consists of the silt that has collected in settling basins into which have been drained the fine tailings from gold dredges. It contains a large percentage of fine silt, and is practically free from either plus 100-mesh material or true colloidal sizes. One sizing analysis[22] showed that 59% of the material was between 1000- and 30,000-mesh, with but 0.4% on 1000-mesh. The tests show that the clay has high dry transverse strength and drying and firing shrinkage, and is only exceeded by the English and Kentucky ball clays in the percentage of water of plasticity, yet the plastic torsional strength and the deformability are low. It is readily distinguishable from Sample 148, which has nearly the same deformability, by its much lower plastic strength. From Samples 296 and 15, which have nearly the same plastic

[21] C. W. Parmelee and C. R. Schroyer, "Further Investigations of Illinois Fire Clays," Ill. Geol. Surv., *Bull.*, No. 38, pp. 278–79 (1922).

[22] W. F. Dietrich, "Clay Resources and Ceramic Industry of California," Calif. Div. of Mines and Mining, *Bull.*, No. 99, p. 338 (1928).

strength, 210 is set apart by its lower deformability and greatly increased dry transverse strength and shrinkage. A striking feature of Sample 210 is its high adsorptive power for both dyes. This feature has no apparent meaning in terms of the other properties studied, especially when it is noted that Sample 61, also a common red-firing clay, has medium dye adsorptive power.

The nature of the plasticity of clays exemplified by Samples 61 and 210, may be examined by studies of the water of plasticity range, and of the changes in the position of the plastic index line with variations in water content.

Conclusions

(1) Experiments with the Talwalkar-Parmelee plasticity test have led to the following tentative generalizations: (*a*) The plastic torsional strength of a clay probably varies directly with the water content. (*b*) The total deformation below rupture tends to increase with increase in the water content. (*c*) Aging of clay in the plastic condition decreases the plastic torsional strength and tends to increase the total deformation before rupture; for a given strength, aging permits the use of less water without lowering the total deformation. (*d*) Progressive additions of finely-ground quartz up to 50% have a tendency to increase the plastic torsional strength and to decrease the deformability of clays; beyond 50% the plastic strength is rapidly decreased by increase of quartz, but the deformability is very slightly affected. (*e*) The plastic torsional strength of a mixture of equal parts of clay and nonplastic matter may be increased by increase in fineness of the nonplastic portion.

(2) The Talwalkar-Parmelee plasticity apparatus is a valuable aid in establishing numerical criteria for distinguishing between various types of clays, which are not clearly segregated by other test data. (*a*) Mixtures of clay and finely divided nonplastic matter have low plastic strength, low water of plasticity, and low firing shrinkage, compared to nonplastic kaolins, such as English china clay. (*b*) Within the limits of a series of closely similar clays, plasticity differences may be related to differences in vitrification temperature, high plastic strength being associated with low vitrification temperature. (*c*) Ball clays are readily distinguishable from clays of inferior plasticity. (*d*) The test may provide quantitative means for distinguishing between the plasticity of common brick clays and that of other red-firing clays which differ from the common clays mainly in their plasticity.

(3) No correlation was obtained between the adsorption of malachite green and of methylene blue by various clays. No correlation was obtained between the amounts of either dye adsorbed and the plasticity or other properties of clay.

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DISCUSSION[1] ON "PREVENTION OF DISINTEGRATION OF BLAST-FURNACE LININGS"[2]

By R. P. Heuer

This paper offers evidence to confirm the already existing belief that the catalytic deposition of carbon in blast-furnace brick is caused by iron compounds of lower state of oxidation than Fe_3O_4 or Fe_2O_3. It would seem, however, that the experimental data presented do not justify the extensive generalizations which the authors offer in conclusions (2), (3), and (4). Especially is this applicable to the assertion that Fe_3O_4 is immune to reduction and cannot therefore become catalytically active for carbon deposition.

Eastman[3] has reviewed the published data on the equilibria of iron and its various oxides with CO and CO_2. He has been able to draw some conclusions on the free energies of formation of Fe_3O_4 and FeO. Figure 1 reproduces Eastman's curves. These curves define the various equilibrium conditions of temperature and ratios of CO_2 to CO under which the different oxides are stable.

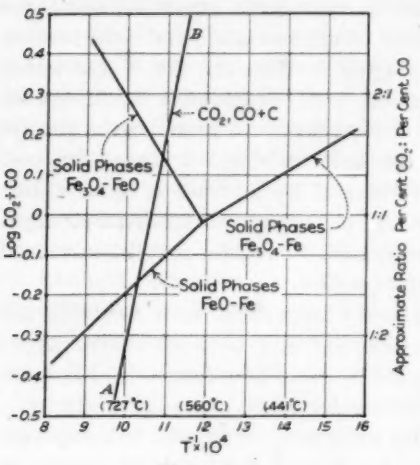

FIG. 1.

Lewis and Randall[4] have evaluated for the reaction: C (graphite) + $CO_2 \longrightarrow 2CO$, the standard free energy change:

$$\Delta F_0 = 40910 - 4.9T\ln T + 0.00495T^2 - 0.00000051T^3 - 12.66T.$$

In Fig. 1, the curve AB expresses the equilibrium concentrations for this reaction.

Carbon deposition can only occur at temperatures and gas compositions which lie in the area to the right of AB. In the particular portions of this area, where carbon deposition is known to occur in blast-furnace linings, Fe_3O_4 is certainly not stable. It would seem, therefore, unsafe to assume from the short experimental runs reported in this paper (14 hours) that Fe_3O_4 if present in blast-furnace brick would not be reduced if subjected to blast-furnace gases over a period of years under actual operating conditions. Indeed,

[1] Received April 21, 1928.

[2] H. K. Mitra and A. Silverman, "Prevention of Disintegration of Blast-Furnace Linings," *Jour. Amer. Ceram. Soc.*, **11** [5], 278–91 (1928).

[3] *Jour. Amer. Chem. Soc.*, **44**, 994 (1922).

[4] Thermodynamics, McGraw-Hill Book Co., 1923.

the authors record that a sample of natural occurring magnetite, which they tested, actually deposited 1.1% of its own weight of carbon when subjected to CO for 6 hours. This is at least sufficient to question the statement that Fe_3O_4 is incapable of becoming catalytically active in blast-furnace brick.

In view of the above, the authors' recommendation that blast-furnace brick be especially treated to convert the iron oxides to Fe_3O_4 is at least open to question. Their desire to put the oxides of iron into a form which is difficultly reducible is rational enough. Indeed, this thought has already been incorporated into the manufacture of at least some of the better brands of blast-furnace brick. The method employed differs from the one the authors are patenting. Instead of developing free Fe_3O_4, this process converts the free iron oxides into the eutectic of the system FeO–$Al_2O_3 \cdot 2SiO_2$, which is reported to contain 40% FeO under proper firing conditions. This eutectic can be formed around 1100°C. When so formed it can be subjected to strong reducing atmospheres without attack. It is a much safer constituent of blast-furnace brick than any of the free oxides of iron, either magnetite or Fe_2O_3. In laboratory tests, which normally cause considerable carbon deposition on natural magnetite or Fe_2O_3 in a few hours, the silicate eutectic shows no carbon deposition from CO after several hundred hours' exposure.

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CYANITE AS FOUND IN WESTERN NORTH CAROLINA[1]

By A. H. Fessler and Wm. J. McCaughey

ABSTRACT

This article describes briefly the deposits, formations, geology, and economic value of the mineral cyanite as found in western North Carolina.

Introduction

The intensive research and continued expansion of modern industry leads to increased demands for minerals and their products, as well as new uses for minerals heretofore considered of no commercial importance. This tendency is evident in the rapid strides being made in the investigation, utilization, and developments in new applications of the andalusite-sillimanite-cyanite group of minerals, all of which a few years past were only of minor interest, but are now receiving the ever-increasing attention of the ceramic and refractory industries.

Cyanite

The mineral cyanite crystallizes in the triclinic system. Its color may be blue, gray, green, or brown. It is vitreous in luster and has a hardness of 5 to 7.5 at right angles to length and 4 to 5 parallel to the length. Its specific gravity is 3.5 to 3.7. Cyanite differs from the other minerals of this group in that it crystallizes in the triclinic instead of the orthorhombic system, has a higher specific gravity, and is slightly softer in the scale of hardness. It occurs as other silicates of aluminum in widely distributed sections but commercial deposits are known in California, Virginia, British Columbia, Georgia, and western North Carolina.[2]

General Geology

The cyanite occurring in the southern Appalachian district is part of the eastern crystalline belt. The rocks of this belt consist of a series of very old formations, part of which were originally sedimentary and part igneous. These original rocks have been highly metamorphosed and so completely recrystallized that the original structures and textures have disappeared. The result is that the present rocks consist of gneisses and schists which have been intricately folded, crumpled, and sheared.

Deposits

The cyanite occurs in two general types of deposits. The first is the disseminated type in which the cyanite is distributed through a schistose

[1] Received Oct. 22, 1928.

[2] W. M. Meyers, "New Uses of Nonmetallic Minerals," Bur. Mines, *Serial*, No. 2587.

rock, forming 5 to 50% of the rock. These deposits would require milling to extract the cyanite from the associated minerals, and because of the perfect cleavage of the cyanite, it is believed that extraction or concentration will be somewhat difficult and the product probably not of a high grade. On the other hand these disseminated deposits in the schists are fairly uniform in their occurrence and composition.

The disseminated cyanite deposits may in turn be divided into three general types with many variations and combinations of the three types found in one deposit. This division is based on the properties of the rock containing the cyanite crystals and also on the form and size of the crystals themselves. As has been mentioned, the size and form of the cyanite crystals vary and many forms may be found in the same deposit.

In Soft Rock The cyanite crystals are found in layers in the Carolina gneiss. This is a soft rock composed of cyanite, muscovite mica, hornblende, garnet, and some quartz. The cyanite is found in distinct layers as well as scattered throughout the rock in crystals from 2 inches in length to very fine particles. The crystals are flat and usually gray, pale green, or blue. They lie parallel with the foliation of the rock and on a weathered surface stand out prominently from the rest of the rock.

J. T. Stuckey, consulting geologist, reports that on one of these deposits which he examined, he estimated that the cyanite varies from 5 to 40% of the total rock mass and that a recovery of 15% from the rock might be expected. In order, however, to obtain a product free from mica and garnet there might be a loss of 20 to 25% of the total cyanite extracted from the rock. Even with such a loss, 10 or 12% of cyanite should be expected. This deposit has one "vein" approximately 1000 feet wide and 4000 feet long. Several cliffs and outcrops of rock standing up over 50 feet high are evidence that the cyanite extends to a depth of at least 50 feet. Many deposits have been located containing this type of cyanite.

In Hard Rock This type of cyanite is found in a region which has also undergone intense regional metamorphism. The cyanite crystals are found in the Carolina gneiss and with veins of pure cyanite associated with quartz, running through the gneiss. There are many prominent exposures of the cyanitized schist, consisting of bladed crystals of cyanite scattered more or less through a matrix of quartz grains, muscovite mica, garnet, and minor minerals. This schist formation shows every gradation in the form of cyanite crystals. The cyanite occurs (1) as lenses in which the mineral forms an almost pure aggregate, (2) as an evenly spotted rock containing stringers of cyanite, and (3) as compact masses of crystals as much as six inches in length with pro-

portionate width and thickness. Ore bodies of the pure mineral are irregular in shape and variable in size. Known croppings of such lenses range from 4 feet upward in width with irregular outcroppings for over 1000 feet in length. The depth is unknown due to lack of prospecting.

In Very Soft Rock

This type of cyanite also occurs in the Carolina schist, but unlike the other two types the deposits are apt to be small. It is found in places in a soft easily-broken schist. The schist has been badly erroded and consequently in the lower altitudes and valleys many tons of free cyanite crystals are found. The crystals are 1 to 2 inches long and from $^1/_4$ to $^3/_8$ inch in width and about $^1/_8$ to $^1/_4$ inch in thickness. The mineral occurs distributed in the foliated rock in parallel seams. At places it makes up to 5% of the rock, but it is not uniformly distributed in the rock in the direction perpendicular to the lamination. On account of the uneven distribution in the layers of rock, it is difficult to arrive at any conclusion as to its quantitative distribution. Cyanite crystals often occur in a 12-inch layer and the rock on either side is barren. At other places it occurs in smaller seams which appear to be different layers than the larger one. The cyanite is very rough and of a dark brown to a black color, due in part to inclusion of graphite and other minerals. Biotite, mica, and garnet are intimately associated with it and preclude the possibility of using this cyanite for porcelain, as the material on calcination becomes slightly paler but remains somewhat brown in color. When mixed with 50% clay and fired to cone 18 the body is of a light brown color.

Undisseminated Deposits

This type of cyanite deposits should be of greater ceramic value if the mineral deposits are constant. In these deposits the cyanite occurs in lenticular masses weighing from 100 lbs. to several tons in weight, and as large bladed crystals of a blue or green color. These crystal groups are generally of a high degree of purity and are so coarsely crystallized that they are very easily sorted from any associated impurity. The cyanite is found in large bladed crystals, in a soft mica schist as country rock generally of a low quartz content. These schists were at one time sedimentary deposits similar to shales, but in the mountain building processes the rock has been completely metamorphosed into a fine-grained iron-stained mica schist. The absence of free quartz makes the schist very soft. The bedding plane of these schists is now nearly vertical (70° from the horizontal) and it strikes almost uniformly through the country along a line 40° east from north. Loose cyanite boulders can be found along the strike of the schists, but these boulders are never continuous either vertically or horizontally. There are stretches of barren ground and then a showing of cyanite. The recurrence of these boulders along the strike of these soft schists gives it somewhat the appearance of a mineral vein. Many such veins are found

in this district, and the boulders occur in a straight line. It is to be understood, however, that these deposits are not continuous but have been traced for 7 miles, occurring in the same country rock (soft mica schist) and approximately in the same strike.

In nearly all the cases where these lenses of cyanite occur, pegmatite dikes are found crossing these veins of cyanite at a low angle. The cyanite boulders occurred in the soft mica schist at or near the contact of the schist with the pegmatite. This occurrence is very typical of this region. Sometimes the pegmatite is not present as the (quartz-orthoclase) rock but in its place occurs the sugar quartz into which the pegmatite passes at times along its strike or outcrop. The occurrence of cyanite where the pegmatite crosses the high-alumina low-silica mica schists seems to be indicative of its origin. It is believed that the cyanite owes its origin to an assimilation of the country rock by the pegmatite or to the pneumatolytic action of the pegmatite on the country rock. These pegmatite veins vary from 18 inches to 6 or 7 feet in thickness and are generally vertical, not following the bedding plane of country rock either in dip or in strike. If the origin is due to assimilation of the country rock by the pegmatite or as a wall rock, it should be more or less continuous along the vertical contact of the soft mica schist and the pegmatite. As the pegmatite passes out of the soft schist into the harder quartz schist or hornblende schist the cyanite is no longer present. Pegmatites are dike rocks and represent the final stages of consolidation of an igneous rock. Ordinarily they are simple in their mineral composition, containing about $^3/_4$ orthoclase and $^1/_4$ quartz. Another possible explanation of the origin of the cyanite is that it may be due to pneumatolytic action of the hot gases evolved from the pegmatite reacting on the soft schist and dissolving silica from clay forming cyanite and SiF_4 (gas). If pneumatolysis is responsible for the occurrence of cyanite, the mineral would be sporadic and likely to occur at the contact with the mother rock or in wall rock itself, and would not necessarily have a constance of occurrence either vertically or horizontally.

Another type of undisseminated cyanite is found occurring in the pegmatite vein itself. In this case the cyanite forms 10 to 15% of the mass. It is in large crystals ordinarily $1^1/_2$ inches wide by 8 to 14 inches long and $^1/_4$ to $^1/_2$ inch thick. The rock is very friable and the crystals spall out readily, perfectly free from quartz and other associated minerals. The cyanite is beautifully transparent or translucent and is not stained with iron or other mineral. The pegmatite dikes follow the strike of the country rock and are inclosed in the soft mica schists. The extremely high degree of purity of the mineral found in these deposits and the ease of separation warrants development if found in sufficient quantity. The origin of this cyanite is probably due to assimilation of the wall rock which ordinarily has been highly argillaceous but is now highly schistose.

Concentration

It has been reported that a separating process has been developed which will give 100% cyanite. Impurities such as mica and quartz are removed quite easily due to the difference in specific gravity, but minerals like garnet, tourmaline, staurolite with specific gravity almost identical with that of cyanite are troublesome. Such minerals are contact metamorphic minerals like cyanite; therefore they are usually intermixed to such a degree that it is rather difficult to remove them without losing a large per cent of the cyanite, although it is reported that by proper grinding, screening, and passing over high intensity magnetic separators that these impurities can be removed. When the cyanite contains rutile and muscovite as inclusions or as intercalated minerals, the complete separation is extremely difficult, if at all possible.

Summary

The mineral cyanite as found in western North Carolina may be divided into the following classifications:

(1) Disseminated type: (*a*) found in soft rock composed of mica, hornblende, garnet, and some quartz; cyanite crystals medium to small; many deposits of this type are found and they represent an immense tonnage of cyanite; (*b*) found in hard rock composed of quartz, mica, garnet, and other minerals; cyanite crystals range from large to very small with veins of pure cyanite; it is very common and also represents an immense tonnage; (*c*) found in a soft, friable schist rock composed of iron-stained mica; cyanite crystals are large and easily separated, are stained with iron, and would be suitable only for the industries where final color is of no importance; deposits are apt to be small but offer good concentrating possibilities.

(2) Undisseminated type: (*a*) lenticular masses composed of large, coarse crystals occur in veins of doubtful depth; it is a very pure form of cyanite and practically free from impurities; (*b*) the cyanite occurs in large crystals and is found in pegmatite veins; the crystals are easily separated from the quartz and offer a source of very pure cyanite; deposits are few and the quantity is rather doubtful.

The many types of cyanite found in this locality offer many possibilities for their utilization and the immense tonnage offers unlimited use and development.

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VANADIUM AND MOLYBDENUM COMPOUNDS IN CLAYS[1]

By L. A. Palmer[2]

ABSTRACT

Eight different light-firing clays and shales containing small amounts of insoluble vanadium and molybdenum compounds were studied. It was found that during firing, soluble salts of these elements were formed which later appeared as a green-yellow efflorescence on the fired clay. The color of the efflorescence was chiefly due to alkali vanadates.

It was found that the use of either sodium fluosilicate or calcium fluoride is effective in eliminating the green-yellow efflorescence. The use of these chemicals is usually a more economical procedure than either hard firing or the use of lead compounds. The results of various trial firings made with clays to which were added varying amounts of several different chemicals are given.

Introduction

Although the elements, vanadium and molybdenum, are quite widely distributed among various clays and shales, they are usually in very small amounts. Seger[3] identified both elements in lignite clays of northern Germany and showed that they were the source of a green-yellow efflorescence that sometimes developed on terra cotta bodies made from these clays. In the analyses of the green salts, he found that potassium vanadate was the chief constituent and that to a much lesser extent, potassium molybdate. The wide distribution of vanadium in minerals, coals, clays, sandstones, and igneous rocks has been clearly established by Hillebrand[4] and his co-workers.

To find the exact amounts of rare elements present in the clays used in the manufacture of building brick is time-consuming and difficult, and usually there is no need for such analyses. Usually they are present in such small amounts that the errors due to overlooking them are smaller than the errors in the determination of the more abundant constituents. For example, the figures for the oxides of iron in clays would not be materially affected in most cases by ignoring the presence of vanadium.

Green efflorescence on the exterior surfaces of brick walls is infrequent in comparison with white efflorescence. The causes of and remedies for the usual white efflorescence have been studied.[5] Light buff brick sometimes develop a yellow-green efflorescence, more properly called a stain, owing to the difficulty of its removal.

This green or yellow stain sometimes changes to a variety of colors,

[1] Publication approved by the Director of the Bureau of Standards of the U. S. Department of Commerce. Received Sept. 28, 1928.

[2] Research Associate.

[3] Collected writings of Herman A. Seger, Vol. I, p. 385 *et seq.*

[4] W. F. Hillebrand, "Distribution and Occurrence of Vanadium and Molybdenum in Rocks of the U. S.," *Amer. Jour. Sci.* (Series 4), **6**, 209 (1898).

[5] L. A. Palmer, "Efflorescence and Kiln and Dry House Scum," Bur. Stand., *Tech. Paper*, No. 370.

often becoming blue or reddish brown. These changes of color are perhaps connected with some condition of the atmosphere. When these efflorescent salts (initially green or yellow) have so changed in color, they resemble iron, nickel, cobalt, or copper salts. It is this resemblance which may account for many statements that efflorescence observed on ceramic material was composed of these latter salts. This colored efflorescence is more frequently noted on the lighter colored clay bodies simply because the green-yellow color is more noticeable on a light background.

There are apparently no water soluble compounds of vanadium or molybdenum existing as such in clays prior to firing. In some way the insoluble compounds of vanadium and molybdenum are rendered soluble during the vitrifying process. Furthermore, according to Seger[5] these soluble salts so formed become again insoluble if heating is continued and complete vitrification is closely approached. This varies widely among different clays, hence it would seem that the disappearance of the soluble compounds of vanadium and molybdenum is not effected through their decomposition (which would proceed at a fairly definite temperature) but rather through their fusion with certain other components of the clay.

Vanadium may be present in a variety of forms in clay. According to Mingaye,[6] vanadium as the pentoxide comprises up to 0.1% of many French and Australian clays. Hillebrand[7] mentions the wide distribution of roscoelite among sandstones.

This mineral is essentially a vanadio-alumino-potassic silicate or some other very similar silicate. Vanadium[7] also occurs quite extensively as Hewetite and meta-Hewetite, $CaO{\cdot}3V_2O_5{\cdot}9H_2O$, and Pascoite, $Ca_3V_6O_{17}{\cdot}11H_2O$. Vanadium and molybdenum may also be present in clays in the form of oxides and sulphides. The latter would, of course, tend to be converted to oxides during firing.

In attempting to get rid of the soluble vanadates and molybdates by vitrification, overfiring may result. This also is expensive, involving a greater consumption of fuel and a longer time than would ordinarily be used. Although the addition of lead compounds to a clay is effective, it is an expensive procedure.

Studies by American Face Brick Association

To determine the essential facts concerning the various kinds of efflorescence developing on brick walls, the American Face Brick Association

[6] *Rec. Geol. Surv. of New S. Wales,* **7** [3], 212 (1903).

[7] W. F. Hillebrand, "Analysis of Silicate and Carbonate Rocks," U. S. Geol. Surv., *Bull.*, No. 700, pp. 26–27. W. F. Hillebrand, H. F. Merwin, and F. E. Wright, "Classification and Physical and Optical Properties of Hydrous Calcium Vanadates," *Proc. Amer. Phil. Soc.*, **53**, 31–54.

sponsored an extensive investigation[5] of the general subject, "efflorescence." This included the comparatively minor problem of green efflorescence.

Materials Eight different clays were studied. These clays were being used in light buff face brick and were received in barrel lots from manufacturers from widely distributed points of the U. S.

Chemical Analysis The standard procedure as described by Lundell[8] was closely followed in determining quantitatively the percentages of vanadium, chromium, etc. The results are given in Table I.

Molybdenum is readily separated by precipitating it as the sulphide prior to the determination of chromium and vanadium. It is necessary, of course, to remove all traces of sulphides following the precipitation of molybdenum. This is effected by first boiling to remove most of the H_2S in solution and then following this by the addition of bromine and subsequent repeated boiling to oxidize to sulphates any remaining sulphides.

In the analyses of the green salts developed on the fired brick a more direct procedure could be followed since no silica, iron, or alumina are contained in such salts.

The colorimetric method as described by Lundell[8] was used for determining chromium and vanadium in all cases. Molybdenum was precipitated as the sulphide from solution made slightly acid (1%) with sulphuric acid. The cold solution was saturated with hydrogen sulphide in a small pressure flask. The flask was then closed, heated on the steam bath overnight until the precipitate settled, allowed to cool, and then filtered. The precipitate was washed with dilute sulphuric acid and finally with alcohol until the last trace of acid was removed. The moist filter was placed in a porcelain crucible and dried on the water-bath. The crucible was then covered and very carefully heated over a small flame until no more hydrocarbons were expelled. The cover was then removed, the carbon burned from the sides of the crucible at as low a temperature as possible and by raising the temperature gradually, the sulphide was changed to oxide. When oxidation was about complete the crucible was cooled and there was added to its contents a little HgO suspended in water. The mixture was stirred and allowed to evaporate and then by gentle ignition, the mercury was expelled. This procedure eliminates the last trace of carbon without any volatilization of molybdenum. The residue remaining in the crucible was then weighed as MoO_3. This residue should be dissolved in NH_4OH or NaOH and corrected for impurities or else the molybdenum should be determined colorimetrically.

The analyses of the eight clays were as follows:

[8] "Methods of Chemical Analysis," *Jour. Amer. Ceram. Soc.*, **11** [6], 351–56 (1928).

TABLE I

ANALYTICAL RESULTS

Clay	V	Cr	Mo
1	None	0.04	None
2	0.03	None	0.07
3	0.04	0.02	0.04
4	0.005	None	0.01
5	0.04	None	0.09
6	0.01	None	0.02
7	0.09	None	0.09
8	0.003	None	0.01

The percentages of molybdenum present in these clays are approximately the same as the percentage of vanadium. Hillebrand[9] has stated that vanadium occurs in appreciable amounts in the more basic, igneous, and metamorphic rocks but that it seems to be absent (or nearly so) from the highly siliceous rocks. Molybdenum on the other hand, according to Hillebrand, appears to be confined, in quantities susceptible of detection, to the more siliceous rocks. It is possible that the same general rule applies among the various clays and that highly siliceous clays are particularly apt to contain molybdenum.

To develop enough of the green-yellow salts for analyses, several brick were molded from each of the clays in Table I and fired in an oxidizing atmosphere to 1750°F. Then at least six brick representative of any one clay were stood on end in a shallow pan containing distilled water (about one inch in depth) for several days. The amount of these salts accumulating on the dry ends was exceedingly small in every instance. It is likely that the calcium and magnesium sulphates appearing on the dry ends would, in the absence of vanadium and molybdenum salts, not be noticeable. The latter, due to their intense green-yellow (sometimes golden) color, make more conspicuous any deposit of salts with which they are mixed.

The analyses of the soluble salts is given in Table II. These analyses

TABLE II

ANALYSES OF GREEN-YELLOW SALTS DEVELOPED ON BRICK

	Brick of clay No. 2 (%)	Brick of clay No. 3 (%)	Brick of clay No. 5 (%)	Brick of clay No. 7 (%)
Silica	None	None	None	None
Fe_2O_3 (occurring as sulphate)	None	None	None	0.82
Al_2O_3 (occurring as sulphate)	None	None	None	1.64
V_2O_5	10.88	7.44	14.85	11.84
MoO_3	1.80	1.38	1.43	0.46
Chromium	None	None	None	None
CaO (occurring as sulphate)	12.26	10.99	14.20	14.12
MgO (occurring as sulphate)	3.54	3.97	4.02	4.14
SO_3	45.28	44.81	41.83	42.37
Na_2O	5.83	15.02	4.58	6.54
K_2O	20.75	17.01	19.21	18.25
Total	100.34	100.62	100.12	100.18

[9] *Loc. cit.*, p. 184.

were computed on the basis of the weight of the sample of such salts taken for analysis subsequent to being held at 120 to 130°C for a period of 12 hours to remove water of crystallization.

Chromium was not found in the soluble colored efflorescence on any brick made from any of the eight clays.

Relatively small quantities of molybdenum were found in the effloresent material even though the raw clays contained generally slightly more molybdenum than vanadium.

Prevention of Green Efflorescence

Addition of sodium carbonate or potassium carbonate to a clay containing insoluble vanadium tended to cause in every instance a marked increase in the amount of green efflorescence on the fired clay body. This would indicate that the insoluble vanadium compound is converted to a soluble alkali vanadate during firing. It is likely that there is originally present in most clays a sufficient quantity of Na_2O and K_2O to form the soluble vanadates to a greater or lesser extent and that the addition of these alkalis to a clay already containing a certain amount of such merely serves to increase the extent to which the soluble alkali vanadates are formed during firing.

Since the analyses showed that the amount of molybdenum in the green salts developed on the brick was small, as compared to the amount of vanadium, and since no chromium was found to be present in any of this efflorescent material, the problem of preventing the green-yellow discoloration was narrowed to one of eliminating the soluble vanadium compounds.

Either the molybdenum compounds are volatilized at the higher temperatures or else they become fused with other components of the clay and are thus rendered insoluble. It is possible that both of these processes take place. Clay containing molybdenum was placed in an iron retort and heated to redness. Among the volatilized products, molybdenum was positively identified. This procedure, however, was by no means a quantitative one. No more than barely a trace of the element was ever found in the volatilized materials. A search through existing data shows that the oxide of molybdenum volatilizes appreciably at about 650°C (1200°F).

Both the molybdenum and vanadium existed as insoluble forms in the clays studied. During firing they are changed in some way to soluble molybdates and vanadates. As the vitrification temperature is approached the amount of soluble vanadium salts in any clay becomes distinctly less and soluble molybdenum salts practically disappear. Hard firing would therefore seem to be an effective procedure for eliminating green efflorescence.

Firing in a reducing atmosphere has been recommended by Seger. This procedure in the case of light-firing clays is usually apt to develop a less desirable shade or color.

Chemical treatment of the clay would therefore seem to be the more practicable means of eliminating the green stain. In finding such means due consideration must be given to the cost involved.

Chemical Treatment Lead forms insoluble lead vanadate and molybdate and lead compounds have been used successfully in overcoming green efflorescence. Manufacturers who have used this method report that the amount of the lead carbonate, oxide, acetate, etc., necessary to effectively check the appearance of the green stain must be far in excess of the calculated quantity necessary to convert to lead vanadate the vanadium compounds present in the clay. This would naturally be expected of any chemical treatment of clay. There can be no very intimate contact between the added chemical and the vanadium in the presence of a relatively large amount of clay unless the chemical so added is adequate in amount and has been very thoroughly mixed with the finely ground clay.

A search of the existing data indicates that, theoretically at least, it would be possible to form a volatile halogen compound with vanadium. W. Prandtl and H. Manz[10] heated V_2O_5 and CaF_2 in a platinum apparatus in an atmosphere of nitrogen free from moisture and oxygen and noted the formation of a colorless gas. This gas was essentially a mixture of VOF_3, and VOF_2. E. B. Auerbach and K. Lange[11] fused NaCl and V_2O_5, in platinum and observed a loss of V_2O_5, free Cl_2, and NaCl and a formation of $3Na_2O.V_2O_5$ in the nonvolatile residue. With anhydrous $BaCl_2$, only 0.7% of the V_2O_5 was volatilized. Jannasch and Harwood[12] volatilized vanadium by passing CCl_4 vapor over Na_3VO_4, $NaVO_3$ and NH_4VO_3 each held at red heat. It is seen also from the tables contained in any good chemist's handbook that VF_3 sublimes at red heat while VF_5 boils at 112°C.

In searching for a cheap chemical which could be relied upon to eliminate soluble salts of vanadium in a brick during firing, the possibility of using fluorides for such a purpose was not overlooked. It seemed possible that either the vanadium could be volatilized by combining it with fluorine or that the fluoride added might flux with the vanadium and other components of the clay, and so render the vanadium insoluble.

There are few comparatively inexpensive fluorides on the market. At the time of making the investigation, the cheapest of these were calcium

[10] W. Prandtl and H. Manz, "Action of CaF_2 on V_2O_5," *Kgl. Bayr. Akad. Wissensch.*, (Munich) *Ber.*, **44**, 2582–85.

[11] E. B. Auerbach and K. Lange, *Z. angew. Chem.*, **25**, 2522–23.

[12] P. Jannasch and F. Harwood, *Jour. prakt. Chem.*, **80**, 127–34(1910).

fluoride and sodium fluosilicate. These compounds together with other fluorides were tried. Preliminary work incidental to the study of white efflorescence had already indicated that no elimination of soluble vanadium salts could be effected with either barium chloride or barium fluoride, hence these chemicals were not used in any later investigation.

Procedure Method Trial firings were first made of brick molded from the eight clays without any chemical treatment. These brick were fired in an oxidizing atmosphere in a gas-fired kiln to approximately 1700 to 1750°F. Brick made from Clays 2, 3, 5, and 7 developed green efflorescence to a greater extent than did brick made from the other four clays and accordingly most of the subsequent experimental work was done with Clays 2, 3, 5, and 7.

Approximately 6 lbs. of clay were used in forming a brick. The amount of chemical added was computed as per cent by weight. The clays used were very finely ground. The chemical used, regardless of its solubility in water, was added to the mixing water. The amount of mixing water used was approximately the same in all tests, being sufficient to give to the clay the desired workability. The molded brick were dried in a gas-fired oven for approximately 48 hours and then fired in an oxidizing atmosphere in a gas-fired kiln for a definite period and at a definite temperature. A platinum platinum-rhodium thermocouple in connection with a recording potentiometer indicated the temperature in the interior of the kiln at regular and frequent intervals of time.

After firing and cooling, the brick were removed from the kiln and stood on end in a shallow pan containing about an inch in depth of distilled water. This depth of water was kept constant for several days by frequent renewals to replenish loss from evaporation. If green efflorescence developed at all, it did so in a comparatively short time. It usually was developed to its fullest extent at the end of three or four days.

The results are given in Table III.

TABLE III

RESULTS OF VARIOUS CHEMICAL TREATMENTS ON CLAYS

Clay	Sample	Number of brick made	Added to clay	Approximate cost of chemical per 1000 brick	Fired to temperature (°F)	Efflorescence developed
2	2 A	2	3/4% ammonium fluoride	$9.45	1735	Green barely noticeable
2	2 B	2	1/2% ammonium fluoride	6.30	"	No green
2	2 C	2	1/4% ammonium fluoride	3.15	"	Green barely noticeable
2	2 D	2	3/4% lead carbonate	4.05	"	No green
2	2 E	2	1/2% lead carbonate	2.70	"	" "
2	2 F	2	1/4% lead carbonate	1.35	"	" "
2	2 G	2	Nothing		2150	" "
3	3 A	2	3/4% ammonium fluoride	9.45	1735	" "
3	3 B	2	1/4% ammonium fluoride	3.15	"	" "
3	3 C	2	Nothing		2150	Green barely noticeable
3	3 D	2	1/2% ammonium chloride	1.50	"	No green
3	3 E	2	1/2% ammonium fluoride	6.30	"	" "

TABLE III (*Continued*)

Clay	Sample	Number brick	Added to clay	Approximate cost of chemical per 1000 brick	Soaking temperatures (°F)	Efflorescence developed
5	5	5	Nothing		1700	Green very noticeable
6	6	5	"		"	No green
7	7	5	"		"	Green very noticeable
8	8	4	"		"	No green
3	3 F	2	1/2% sodium fluosilicate	1.35	1900	Green noticeable
5	5 A	2	Nothing		2150	" "
5	5 B	2	2% dolomitic (?) limestone		1900	No green
5	5 C	2	1/2% ammonium chloride	1.50	"	Green barely noticeable
5	5 D	2	1/2% sodium fluosilicate	1.35	"	" " "
5	5 E	2	1/2% lead carbonate	2.70	"	No green
7	7	4	Nothing		2150	Green very noticeable
7	7 A	2	2% limestone (?)		"	" " "
7	7 B	2	1/2% ammonium chloride	1.50	"	Green noticeable
7	7 C	2	1/2% ammonium fluoride	6.30	"	Green barely noticeable
1	1	12	Nothing		1700	Green
2	2	5	"		"	"
3	3	5	"		"	"

Clay	Sample	Number brick	Added to clay	Approximate cost of chemical per 1000 brick	Soaking temperatures (°F)	Efflorescence developed
7	7 E	2	3/4% sodium fluosilicate	$2.05	1800	No green
7	7 D	2	1/2% sodium fluosilicate	1.35	"	Green barely visible
7	7 F	2	1% sodium fluosilicate	2.70	"	No green
7	7 G	2	1/2% hydrofluosilicic acid		"	" "
7	7 H	2	1% sal ammoniac		"	Noticeable
7	7 I	2	2% dolomitic limestone (Minnesota limestone)		"	Very little green, large quantities of white
7	7 J	2	Nothing		"	Noticeable
7	7 K	2	1/2% lead acetate	6.00	"	Noticeable but better than 7 J
7	7 L	2	1/2% lead carbonate	2.70	"	Some noticeable green, better than 7 K
7	7 M	2	2% dolomitic limestone (Cedarville)		"	Very noticeable white tinged with green
7	7 N	2	2% dolomitic limestone (Minnesota)		"	Noticeable white tinged with green
7	7 O	2	1% calcium chloride	0.60	"	Pronounced green-yellow
7	7 P	2	1/2% litharge (yellow lead oxide)	3.00	"	Noticeable green
7	7 R	2	1/2% lead carbonate	2.70	"	Noticeable green, but better than 7 P
7	7 S	2	1/2% lead acetate	3.00	"	Noticeable green, about the same as 7 R
7	7 T	2	1/2% sodium fluosilicate	1.35	"	Green noticeable but better than 7 P, 7 R, or 7 S
7	7 A-1	2	3/4% sodium fluosilicate	2.05	"	No green but brick are darker than when no chemical is added
7	7 B-1	2	1% sodium fluosilicate	2.70	"	No green, but brick are darker than when no chemical is added
7	7 C-1	2	1 1/2% sodium fluosilicate	4.05	"	No green, but brick are darker than when no chemical is added

3	3 G	2	1% sodium fluosilicate	2.70	1800	No green; color slightly deeper buff
3	3 H	2	1½% sodium fluosilicate	4.05	"	No green; color slightly deeper buff than 3G
3	3 I	2	½% sodium fluosilicate	1.35	"	No green; color slightly deeper buff than sample to which no chemical was added
3	3 J	2	¾% sodium fluosilicate	2.05	"	No green color about the same as 3 I
8	8 B	2	½% sodium fluosilicate	1.35	"	None
8	8	2	Nothing		"	Noticeable green
7	7 D-1	2	½% sodium fluosilicate	1.35	1850	Slightly noticeable
7	7	2	Nothing		"	Very noticeable green
3	3 K	2	½% sodium fluosilicate	1.35	"	No green
3	3	2	Nothing		"	Noticeable green
7	7 E-1	2	½% sodium fluosilicate	1.35	2000	Green barely visible
7	7	2	Nothing		"	Green very pronounced; no improvement over brick fired at 1850°F
3	3	2	Nothing		"	Green very pronounced; no improvement over brick fired at 1850°F
3	3 L	2	½% sodium fluosilicate	1.35	"	Slight green stain
2	2 H	2	½% sodium fluosilicate	1.35	1950	" " "
2	2	2	Nothing		"	Green very noticeable; appeared within 4 hours after standing on end in water
3	3	2	Nothing		"	Green very noticeable; appeared within 4 hours after standing on end in water
3	3 M	2	½% sodium fluoride	6.00	"	No green, but surface of brick blistered; shade undesirable
7	S 7-A	2	1% calcium fluoride	0.60	"	Practically all green eliminated; trace visible after week of soaking
7	S 7-B	2	1% calcium fluoride + ½% sodium fluosilicate	2.00	"	Good but no better than S 7-A
5	5 F	2	½% sodium fluosilicate	1.35	"	Very little green
5	5	2	Nothing		"	Green-yellow very pronounced
7	7	2	Nothing		"	Most noticeable green yet developed
2	2 M	2	1% calcium fluoride	0.60	"	No green
3	3 N	2	"	0.60	"	" "
3	3	2	Nothing		"	Green very pronounced
5	5 G	2	1% calcium fluoride	0.60	"	No green
7	S 7-D	2	1½% calcium fluoride	0.90	1800	" "
7	S 7-E	2	1% lead carbonate	5.40	"	" "
7	7	2	Nothing		"	Very noticeable green

Discussion of Results

Effect of Temperature Alone

Sample 2 G, fired to 2150°F developed no green stain. This brick after firing was practically vitrified. Samples 3 C, 5 A, and 7 fired with Sample 2 G developed the green efflorescence. These brick, however, had none of the characteristics of vitrification.

Lead Carbonate Lead carbonate far in excess of the theoretical quantity to form insoluble lead vanadate and molybdate was required to effectively check any development of green stain in Samples 2D, 2E, 2F, 5E, and S7-E. That the lead compounds did not effectively check green efflorescence in Samples 7K, 7L, 7P, 7R, and 7S must be attributed to the fact that the amount added was insufficient. Clay 7 contained more vanadium and molybdenum than the others. The chief objection to the use of lead compounds is their relatively high cost.

Ammonium Fluoride and Chloride Ammonium fluoride prevented the development of green efflorescence on Samples 2B, 3A, and 3B. Ammonium chloride was used successfully in Samples 3D and 5C, but the use of this chemical tends to darken the shade of the brick.

Limestone Powdered limestone was tried in an effort to lower the temperature of vitrification, serving as a flux, and accomplishing the same result at lower temperatures. It not only failed to check green efflorescence but also increased the amount of white efflorescence, due to impurities in the limestone used.

Calcium Fluoride From the standpoint both of effectiveness in checking green efflorescence and of cost, it is evident that calcium fluoride (fluorspar) is the best choice among the various chemicals used in the treatment of these clays. This is shown in the case of Samples S7-D, 5G, 3N, 2M, S7-A, and S7-B. Calcium fluoride is also preferable to sodium fluosilicate from the standpoint of color since the latter in most cases tends to slightly darken the shade.

Sodium Fluoride Sodium fluosilicate is effective in preventing green efflorescence. This chemical although comparatively cheap (being a by-product in the fertilizer industry) is more expensive than calcium fluoride, and tends to slightly darken the shade. It is sparingly soluble in water whereas calcium fluoride is practically insoluble. The preference given calcium fluoride is from the standpoint of cost.

Whether or not the fluorides effect complete volatilization of the vanadium in any instance when they are mixed with clays was not determined. After several repeated trials it was found that Clay 7 when mixed with 1% (by weight of the clay) of sodium fluosilicate and heated to redness in an iron retort which had a delivery table, lost a very small amount of iron, titanium, vanadium, and molybdenum. These elements were found to be present in very small traces in the distillation products. At a somewhat lower temperature than that at which these elements or their compounds were volatilized, silicon tetrafluoride was volatilized together with water vapor, oils, etc. The amount of vanadium volatilized at a dull

red heat maintained for a period of six hours was exceedingly small, far less than the amount contained in the clay. It is possible, of course, that the temperature was too low to effect a more rapid volatilization of the vanadium. In order to get reliable data on this subject a more extensive study involving the use of expensive equipment would be required.

The immediate need of the investigation was to find the most economical means of preventing green efflorescence. Calcium fluoride and sodium fluosilicate were found to be among the comparatively inexpensive chemicals that would accomplish this. Whether or not they do so by effecting complete volatilization of the vanadium was a matter outside the immediate purpose of the investigation.

Conclusions

The color of green-yellow efflorescence is due chiefly to the presence of soluble alkali vanadates. Chromium was not found in any of the efflorescence of this color. Molybdenum, although present in appreciable amounts in the clays, comprises only a small percentage of the mass of green-yellow efflorescence.

It is probably more economical to prevent green efflorescence by chemical treatment of clay than by relying on firing to higher temperatures. The cheapest chemical that is effective in preventing this green discoloration was found to be calcium fluoride. Sodium fluosilicate accomplishes the same result and is considerably less expensive than lead compounds but more expensive than calcium fluoride at the present market prices.

INSULATION IN THE CERAMIC INDUSTRY[1]

By E. A. Phoenix

ABSTRACT

The following subjects are discussed: (1) heat losses in ceramic kilns, (2) early attempts at reducing heat losses from kilns, (3) properties of an ideal insulation for kilns, (4) advantages of kiln insulation, and (5) various applications of heat-insulating material in the glass plant.

Introduction

One of the important problems for the ceramic engineer is the steadily increasing cost of fuel. Firing costs should be reduced to the lowest possible minimum commensurate with highest percentage of first quality product.

At least 25% of the heat in firing a periodic kiln is lost by conduction through the brickwork and by radiation from exposed surfaces. Considerable heat is absorbed in the brickwork of the walls, bottoms, and flues and in the earth upon which the kilns are built. Raymond M. Howe, before the Kentucky and Southern Ohio Branch of the Refractory Manufacturers' Operatives' Institute in January, 1923, advanced the following heat distribution ranges for the ordinary periodic downdraft kiln:

	Per cent
Lost in unburned ash	1.6– 3.9
Taken up by kiln and lost by radiation	33.3–59.7
Stack loss	27.3–57.1
Used in firing ware	8.0–19.5

The major portion of the loss by radiation is sustained through the relatively thin crowns.

That a great deal of heat is lost by conduction into the ground is evidenced by a Missouri firebrick manufacturer who tore down a kiln and excavated 12 feet below the ground level and found the earth too hot to touch two weeks after the last kiln of ware had been drawn. Damp earth is highly conductive and unquestionably a source of large heat loss. This loss of heat into the ground also causes a considerable drag on bottom temperatures in the kiln.

Heat Transmission

Heat is a form of energy consisting of molecular vibrations of periodic character and subject to the general laws of wave motion, and can be reflected, dispersed, or retarded by suitable mechanical means. Heat is transmitted from one place to another by three methods: radiation, convection, and conduction.

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[1] Presented at the Annual Meeting, American Ceramic Society, Atlantic City, N. J., February, 1928. (Terra Cotta Division.) Received March 15, 1928.

Radiation losses from heated equipment increase with increase in temperature, in fact, as the fourth powers of the absolute temperatures. It is therefore, increasingly important to prevent heat losses at the higher temperatures. The increase of heat loss with increase in temperature is shown in Fig. 1.

Extensive experiments on the emission of heat from red brick surfaces have shown that for practical purposes this is the same as for metal surfaces. It has furthermore been shown that the effect of the color of the surface is so small that it may be disregarded except where very precise results are desired.

The curve shown in Fig. 1 may be used to determine the heat loss from equipment in operation. It is only necessary to measure the exterior temperature and determine the loss in B.t.u. by referring to the chart. It is important to bear in mind, however, that the curve is based on still air conditions and if there is any appreciable air movement, the loss is greatly increased. For instance, with an air velocity of 400 feet per minute (equivalent to 5 miles per hour), a furnace casing or a kiln wall at 300°F is losing about 1000 B.t.u. per sq. ft. per hour, or over 60% more than a wall at the same temperature under still air conditions.

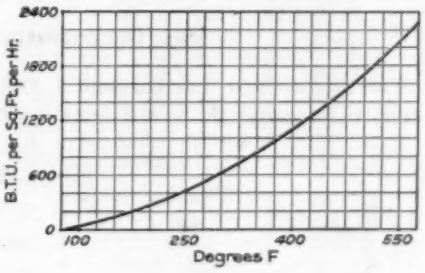

FIG. 1.

Heat is transmitted from the combustion chamber by radiation direct from the burning fuel to the inner surface of the firebrick walls and by convection currents resulting from the moving gaseous products of combustion. The heat then passes through the walls by conduction and ultimately is lost from the outer surface by radiation enhanced by convection caused by air movement outside of the wall.

Probably the first attempt at reducing heat losses from kilns was the building of very thick walls. Walls from 4 to 6 feet thick have been constructed and while they do reduce the loss from the outside surfaces the great mass of brickwork which must be heated assimilates nearly as much heat as would be lost by conduction through a thinner wall. This heat storage capacity is a particular source of loss in periodic kilns as all of this heat is wasted each time the kiln is cooled. Furthermore, the thick walls are expensive in material and labor and occupy needed space. Even had this method been found satisfactory, it would obviously not be feasible on crowns, due to the excessive weight.

Another method tried was the so-called "dead air space" in kiln walls. This method has been used satisfactorily for refrigeration work but at

the temperatures employed in firing ceramic ware this artifice defeats its own purpose because of the fact that the hot surface of the air space radiates heat so rapidly that a greater amount is lost across the space by radiation than would be conducted were the space to be filled with material of relatively high conductivity. The reason for this is that the quantity of heat passing through a portion of a solid wall by conduction depends on the difference between the temperatures of the two planes limiting the portion of the wall; while the quantity of heat that passes by radiation across the air space in the wall depends on the fourth powers of the absolute temperatures of the surfaces enclosing the air space.[2]

Besides the intense radiation through air at high temperatures, there is also rapid convection. Since the average velocity of the molecules in air at 1100°F is approximately 60 miles a minute it might be well to use the term "live air space" instead of "dead air space."

Heat Conductivity through Walls

The rate of heat flow through a wall depends upon the resistance of the component materials to the heat waves. Generally speaking, a material having a low apparent density is considered to be a good insulator. Most materials of this kind contain a number of small "voids" or cells containing air. There is danger, however, of having the cells too large and having radiation across the spaces and convection currents within the cells which increase the apparent conductivity. Roughly speaking, if the cells are large enough to be seen with the naked eye, they are large enough to be instruments of heat transfer by radiation and convection.

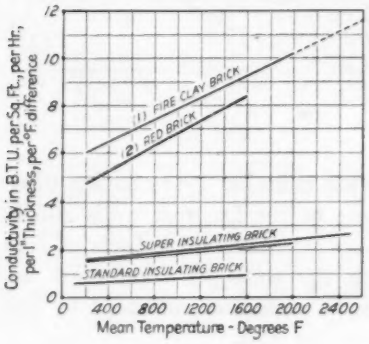

FIG. 2.

Briefly, the ideal insulation for kilns or other equipment, where analogous conditions prevail, should have the following properties:

(1) High heat-insulating value
(2) Sufficient refractoriness so as not to change form or lose its efficiency when subjected to high temperatures
(3) Sufficient mechanical strength to resist wall strains due to expansion and contraction of the brickwork with changing temperatures
(4) Approximately the same coefficient of expansion as the refractory
(5) Light weight (desirable for crown insulation)

[2] This subject is gone into in considerable detail in U. S. Bur. Mines, *Bull.*, No. 8, (1912), "Flow of Heat through Furnace Walls."

The relative thermal conductivities of representative fireclay brick and insulating materials are shown in Fig. 2.

The low conductivity of the insulating brick prepared from diatomaceous silica, is due to the 85% by volume of infinitesimal air cells which effectively break up the heat waves. The term "infinitesimal" is used advisedly as it is estimated that there are from forty to fifty million of these cells in each cubic inch of the natural mineral, diatomaceous silica.

Being practically pure silica (SiO_2) the material has a high melting point (2930°F). This permits its use as insulating material in practically all types of heated equipment.

Diatomaceous silica is composed of the remains of the simplest form of plant life, called "diatoms," which are found in both fresh and salt waters. The microscopic skeletons of the diatoms are pure silica, formed from the water in which the diatoms lived. The deposits in California were probably formed millions of years ago.

Semirefractory types of insulating brick are made by pulverizing the natural diatomaceous silica, molding, and firing in kilns similar to the method followed in the preparation of refractory brick. Insulating brick made in this way are not as efficient as the natural brick but they can be used without shrinkage when subjected to temperatures of from 2000 to 2500°F.

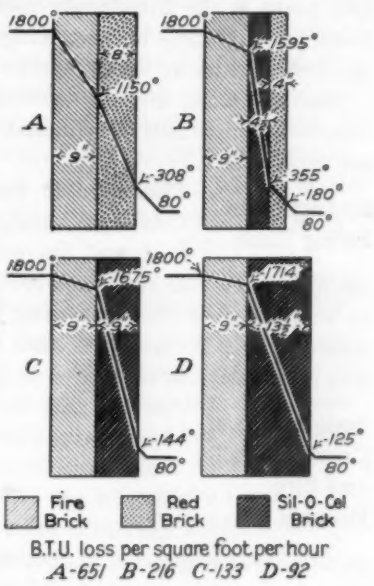

FIG. 3.

Figure 3 indicates temperature gradients and heat losses through typical insulated and uninsulated wall constructions. The first three of these walls are of approximately the same thickness and the degree to which heat loss can be controlled is clearly indicated. For instance, substituting 9 inches of insulating brick for 8 inches of red brick in back of 9 inches of fire brick reduces the exterior temperature from 308 to 144°F and the heat loss from 651 to 133 B.t.u., or a saving of 79%. The use of an additional $4\frac{1}{2}$ inches of insulating brick reduces the heat loss still further to 92 B.t.u. per hour, or a saving of 85% compared to the loss if uninsulated.

Thorough Insulation Standard in Tunnel Kiln Construction

Continuous tunnel kilns, because of the great area of the exposed surfaces, would be very wasteful of heat due to conduction and radiation

unless insulation were used. In fact, the absolute necessity of insulation for this equipment is obvious.

Advantages of Kiln Insulation

The most tangible advantage of kiln insulation is reduction in fuel. Other advantages are, however, considered by many to be of even greater importance.

Improved Heat Distribution

The heat which cannot escape through bottoms, walls, and crowns will naturally tend to distribute itself more uniformly throughout all parts of the kiln. In uninsulated kilns it is often necessary to overfire near the fire pockets and at the tops in order to bring up the center and bottoms. One refractory plant in the Pittsburgh district reduced the percentage of soft brick from 1.2 to 0.25% by insulating crowns and bottoms without increasing the temperature at the fire pockets.

Insulated kilns are not susceptible to atmospheric conditions, which is especially important in climates where wide variations in temperatures are encountered.

Reduction in Firing Time

Considerable reductions in firing time are effected by thorough insulation of kilns, which reduces the labor cost and increases the kiln turnover. At one plant the firing time was reduced from an average of 163 hours before insulating, to an average of 135 hours after insulating. This reduction of over a day would enable 10 insulated kilns to produce the same amount of ware as was previously turned out of 12 uninsulated kilns.

Longer Life of Crowns, Walls, and Fire Pockets

In the past some insulated crowns have given trouble but in these instances the fault was found to be one of construction rather than any fundamental factor of insulating. The crown should naturally always be carefully built of a good quality refractory, the failing point of which under a load is reached at a considerably higher temperature than will be reached in firing of the kiln. Where a good refractory is used there is no danger in insulating. Insulated crowns after six to eight years of use are still in excellent condition. In fact, the effect of insulation is to increase the life of the crown brick due to the fact that the insulation results in a more uniform temperature throughout the nine-inch crown, with a natural reduction in internal stresses and strains and resultant cracking.

Similarly, in the side walls of kilns, insulation prevents excessive temperatures from penetrating to the outer wall of common brick which prevents cracking and obviates any danger of air infiltration.

The necessity of forcing fires is obviated to a great extent by the use of insulation, hence the life of the fire pockets is considerably lengthened.

Savings in Fuel While in some cases the savings have been found to be as high as 20% for thoroughly insulated kilns, a conservative figure would give 16 to 17%.

Cost of Insulating Saved in Thinner Walls Due to the fact that thinner side walls can be built, the cost of including insulation in side walls is little if any more than if insulation were not used.

Insulation in the Glass Plant

During recent years insulation has been used quite extensively for the insulation of producer gas mains, leers, furnace regenerators, etc.

Producer Gas Mains Insulating brick is installed between the refractory lining and steel shell in a glass plant producer gas main. Gas enters the mains in most cases at a temperature of from 1400 to 1600°F. The saving of sensible heat effected by insulation depends, of course, on the size of the installation, and on the size and length of the main. Assuming, however, an installation gasifying 75 tons of coal per day with the average size main the saving due to the insulation amounts to about 1300 tons of coal per year which would be equivalent to a return on the investment of well over 100% per year.

In uninsulated mains the tar vapor condenses and is precipitated as a heavy black tar when the temperature of the gas reaches 800 or 900°F. Condensation of the tar vapor results in a direct loss in heat value of the gas and the heavy tar fouls the mains and furnace reversing valves, causing serious trouble, and necessitating shut-downs. Insulation maintains the temperature of the gases above the critical point and insures delivery of the gas at the furnace with the highest possible heat content.

Annealing Strains in annealing are due to temperature gradients within the ware. Insulation blankets the inner lining so that the heat tends to distribute itself uniformly throughout the ware and the temperature can be controlled very closely.

The fuel saving is, of course, obvious, and this saving alone is sufficient to pay for the insulation within a few months.

There is marked improvement in the quality of the ware and a reduction in the proportion which must be discarded as seconds.

Practically all modern installations of leers are insulated, the extent of insulation depending upon the type of leer and the method of supplying heat. Muffle leers usually are insulated with $4^1/_2$ inches of insulating brick in the walls and with from 5 to 10 inches of insulation over the tops.

There are several electrically heated leers in operation. The success of these installations is due largely to thick layers of insulation.

Glass Melting The overall efficiency of the glass melting operation is seldom higher than 10% based on the proportion of the heat generated and actually utilized in making glass. The insulation of the regenerators or recuperators on continuous tanks will increase their efficiency by insuring the delivery of higher temperature gas and air at the incoming ports.

The principal loss in the glass-melting operation is that sustained by radiation from the furnace itself. The refining ends of continuous tanks have been successfully insulated for a number of years but until recently the high temperatures encountered in the melting chamber have caused operators to avoid anything that might interfere with free radiation from wall and crown.

The short life of tank blocks below the bath level is undoubtedly one of the most difficult problems met with in glass manufacture. One theory[3] for the rapid deterioration of blocks holds that deterioration of blocks manifested by the lines of vertical erosion down the walls, is greatly accelerated by convection currents downward caused by the glass cooling on coming in contact with the tank blocks. Temperature readings have been taken which show that for a 42-inch depth, the temperature of the glass at the bottom of the tank is as much as 400°C (752°F) lower than that at the top.[4] By insulating outside of the tank blocks, this temperature difference and consequent downward convection movement can be almost entirely eliminated. In a test of insulation no lines of vertical erosion and no noticeable corrosion were apparent after thirty days' continuous operation at melting temperatures.

As a result of these tests a number of day tanks were insulated with insulating brick on the outside of the tank blocks. In the three years which have elapsed since these first day tanks were insulated it has been found that the insulation increased the life of the lining. In one plant where direct comparisons could be made between insulated and uninsulated day tanks it was found that combustion temperatures in the insulated tanks were 200°F lower than in the uninsulated tanks and 100% more glass was produced in the insulated tanks.[5] The increase in life of the lining is due to the lower combustion temperatures and to the fact that the insulation cuts down the convection currents and erosion.

There seems to be no reason why insulation should not have the same effect in continuous tanks, but no continuous tank has been insulated except on the refining end. There are opportunities for great savings, not only in fuel but also in labor, time, and material, for replacing tank

[3] W. K. Brownlee, "Insulation of Glass Tanks," *Jour. Amer. Ceram. Soc.*, **7** [6], 457–64 (1924).

[4] *Glass Ind.*, **5**, 125 (1924).

[5] *Ceram. Ind.*, **8**, 154 (1927).

blocks, if the results secured on day tanks can also be obtained in the melting chambers of continuous tanks.

Vitreous Enameling

Furnaces for vitreous enameling, whether periodic or continuous, are practically always thoroughly insulated. In this case also the extent to which insulation is used depends upon the method of heating employed. With electric heat from 15 to 20 inches of insulating material is generally used.

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THE INSULATION OF ROOFS OF GLASS FURNACES

By Robert D. Pike[1]

ABSTRACT

It is unjustifiable to assume that a furnace roof cannot be safely insulated. The principal variables controlling the possibility of safe insulation are: (1) temperature of bath below melting point of silica brick roof; (2) transparency of the atmosphere within the furnace, *i.e.*, no possibility of impingement of dense hot flames. The data of this paper are taken from observations on a glass tank furnace in which the combustion rate (B.t.u. per cu. ft. per hr.) is very low. A testing method is described which will show whether or not insulation is safe for any given furnace, considering only the temperature of the inside face of the brick as affected by the application of insulation. The possibility that if the roof is insulated the progress of fluxing of the silica brick by dust and fumes within the furnace may be accelerated because the higher mean temperature of the brick is considered. In the furnace observed, corrosive dust and fumes were in the gases to a considerable extent, yet no unusual deterioration of the roof brick was noted after three years of insulation under continuous operation.

Introduction

The heat loss by conduction through noninsulated furnace roofs is very great and insulation will lead to important financial saving. When the roof is insulated the outside of the silica brick becomes very hot, often over 1700°F. This produces a very small difference in thermal expansion between the outside and inside dimensions of the brick, which results in a better and more solid face to face contact between the brick when the roof is hot. A silica brick roof in which the inside face of the brick is 2500°F and the outside face 1700°F is a stronger and more monolithic structure than if the outside face were cooled to 500° by direct contact with the atmosphere. This point is emphasized by the well-known property of a silica brick to retain its strength and rigidity up to temperatures just short of its melting point.

The more perfect contact between the brick in a hot roof may also be expected to reduce the outward leakage of hot gases of combustion from the furnace hearth. It is a suggestive possibility, that more uniform heating throughout its length will increase the crystalline homogeneity of a silica brick and reduce the tendency to spall.

Method of Test

The test was made while the furnace was in operation. A roof brick at the crown and about over the center of the flame of the second burner counted from the feed end was removed and replaced with a brick into which three small holes had been drilled, 1 to $2^1/_2$ inches from the outside face, a second to $5^1/_2$ inches, and a third to 10 inches, the last named being

[1] Received May 17, 1928.

within $1^1/_2$ inches of the inside face of the $11^1/_2$-inch roof brick. Small chromel-alumel couples were inserted in these holes so that the couples rested on the bottom and were then tamped firmly into place with sand.

The equation of the temperature gradient curve is derived theoretically as follows: the equation connecting the conductivity, K, of a silica brick with temperature has the following form:

$$K = a + bT \tag{1}$$

in which T is the temperature in °F and $a = 4$, $b = 0.0029$.

K = conductivity B.t.u. per sq. ft. per hr. per in. thickness per °F.

Consider a brick having cross-section of unit area perpendicular to the heat flow. T is the temperature at distance x from the inside face and in passing along distance dx away from the inside face the temperature change is $-dT$. Therefore:

$$W = \frac{-KdT}{dx} \text{ or } -dT = \frac{Wdx}{K} \tag{2}$$

W = B.t.u. per sq. ft. per hr.

and substituting value of K from (1) we get:

$$-adT - bTdT = Wdx \tag{3}$$

integrating:

$$aT + \frac{b}{2}T^2 + Wx = C \tag{4}$$

when $x = 0$, $T = T_1$, when T_1 = temperature of inside face of brick. Therefore.

$$C = aT_1 + \frac{b}{2}T_1^2 \tag{5}$$

and substituting value of C from (5) in (4) we have

$$a(T - T_1) + \frac{b}{2}(T^2 - T_1^2) + Wx = 0 \tag{6}$$

Substituting the known values of a and b gives:

$$4(T - T_1) + 0.00145\,(T^2 - T_1^2) + Wx = 0 \tag{6•}$$

Curve 1, Fig. 1, is plotted from the readings of the thermocouples. The temperature of the inside face by extrapolation is 2450°F.

The observed readings in the brick before insulation was applied are as follows:

Distance from inside face (in.)	Temperature (°F)
$1^1/_2$	2200
6	1375
9	800

Consider the 6-inch point as the inside face, then $T_1 = 1375°$, $T = 800°$, and $x = 3$ inches.

Solving equation (6^a) $W = 1370$ B.t.u. per sq. ft. per hr.

Consider the $1^1/_2$ inch point as the inside face thus: $T_1 = 2200°$, $T = 1375°$, $x = 4.5$ inches.

Solving equation (6), $W = 1685$.

Obviously, W is constant at any cross-section so the difference between the two calculations must be due to error of observation. Average W = loss through uninsulated roof B.t.u. per sq. ft. per hr. = 1528.

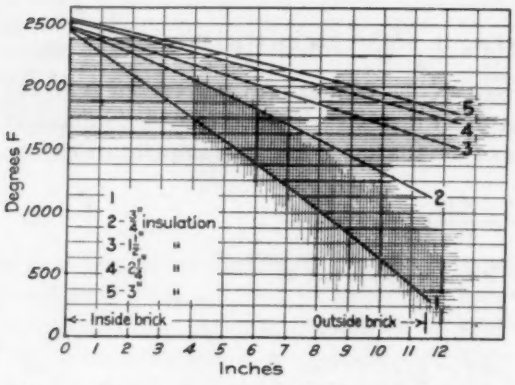

FIG. 1.—Temperature gradients through silica roof brick.

In order to observe the effect of insulation on the temperature of the inside face an area 3 feet square around the thermocouples as a center was covered with successive layers $^3/_4$ inch thick of powdered diatomaceous earth. Twenty-four hours were allowed to elapse after placing each layer so as to get a steady state.

Curve 2, Fig. 1, shows the temperature gradient after $^3/_4$ inch of insulation had been placed. There has been practically no change in the temperature of the inside face. The observed readings for this case are as follows:

Distance from inside face (in.)	Temperature, (°F)
$1^1/_2$	2287
6	1834
9	1445

Considering the six point as the outside face, $T_1 = 1834°$F, $T = 1445°$F, $x = 3$ inches. Solving equation (6^a), $W = 1155$ B.t.u. per sq. ft. per hr.

Next call the $1^1/_2$ inch point the inside face. In this case $T_1 = 2287°$F, $T = 1834°$F, $x = 4.5$ inches; and solving we find $W = 1000$. Average W less B.t.u. per sq. ft. per hr. with $^3/_4$ inch insulation = 1078.

The following are the temperature readings with $1^1/_2$ inch insulation:

Distance from inside face (in.)	Temperature, (°F)
$1^1/_2$	2208
6	2019
9	1787

These readings are plotted in Curve 3, Fig. 1, which, when extrapolated to the inside face, shows a temperature of 2475°F. The temperature reading at the $1^1/_2$ inch point is obviously low. This is due to the failure of the thermocouple at this temperature, which is considerably above its safe working range. The temperature reading at the $1^1/_2$ inch point for this and subsequent observations has therefore been discarded and Curves 3, 4, and 5 of Fig. 1 have been extrapolated as straight lines from the two readings at the 6 and 9 inch points.

Similar data were taken with $2^1/_4$ and 3 inches of insulation and plotted in Curves 4 and 5, respectively, showing a temperature of inside face of 2525 and 2550°F. The inside face temperatures and average heat losses are summarized in Table I.

TABLE I

EFFECT OF INSULATING WITH POWDERED DIATOMACEOUS EARTH ON TEMPERATURE OF ROOF BRICK, AND HEAT LOSS INSULATION APPLIED TO A 3-FT. SQUARE TEST BRICK AT CENTER

Thickness of insulation (in.)	Temperature inside face (°F)	Temperature outside face (°F)	Mean temp.	Heat loss B.t.u. per sq. ft. per hr.
None	2450	300	1375	1528
$^3/_4$	2460	1125	1800	1078
$1^1/_2$	2475	1550	2013	729
$2^1/_4$	2525	1750	2138	675
3	2550	1825	2188	675

The application of $1^1/_2$ inches of powdered diatomaceous earth reduced the loss 52% and $2^1/_4$ inches reduced the loss 56%. Three inches apparently caused no additional saving. This result is probably caused by errors of observation, although the additional saving is small, if any.

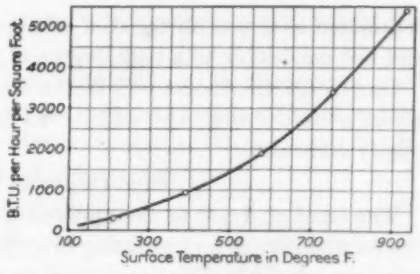

FIG. 2.—Heat loss from vertical surface (Langmuir); temperature of air 80°; air still; for horizontal surfaces exposed up multiply by 1.1; for horizontal surfaces exposed down multiply by 0.488.

In the case with $2^1/_4$ inch insulation the temperature of the outside surface of the brick is 1750° and the outside temperature of the powdered diatomaceous earth to conform with the curve of Fig. 2 is about 300°F. The drop through the powdered diatomaceous earth is, therefore, 1450°F and the total resistance for the passage of 675 B.t.u. per sq. ft. per hr. is 2.15. The resistivity is, therefore, $\frac{2.15}{2.25} = 0.96$, giving $K = 1.05$.

The calculations are all based upon the assumption of parallel flow of heat in the region of the couples. To check up this assumption the tem-

perature of the surface of the brickwork along two axes at right angles intersecting in the thermocouples was measured, using a 20-gage iron-constantan couple. The results plotted in Fig. 3 show a lower temperature at the couples than in the region immediately surrounding them. This slight distortion is probably due to the conduction of heat along the wires, but evidently the area of the insulation has been chosen great enough to eliminate area as a factor in affecting the temperature gradient through the brick. The gradient would be the same if the entire roof had been covered.

The conduction of heat along the couple wires also tends to distort the results somewhat by making all readings too low, particularly those at the 6 and $1^1/_2$-inch points, but the results appear to be fairly consistent and are no doubt of qualitative accuracy. The conditions of the experiment

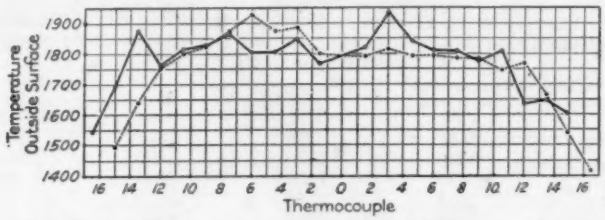

FIG. 3.—Exploration of surface of roof brick to determine parallel flow showing temperatures along axes at right angles with couples at intersection; furnace No. 5 20G iron-constantan couple used.

conducted as it was on the roof of a large furnace in operation, are difficult and not conducive to a high degree of accuracy.[2]

One of the thermocouples in the test brick was connected up with a recorder over the week end and it was found that the temperature was practically constant.

Application to Practice

The chief obstacle to the application of these observations to practice is the availability of an insulating brick which will stand up to this high temperature service. The usual type of brick made by sawing out of natural blocks of diatomaceous earth is useless. The roof of the furnace in question has been insulated for three years with a molded brick made from calcined diatomaceous earth. This brick leaves something to be desired in its refractory and physical properties but further improvements have been made recently in their manufacture. The installed brick is reported by its maker to have a conductivity of 2 (Eng. units).

The following calculation shows the heat loss through the $11^1/_2$ inch silica brick roof insulated with $2^1/_2$ inches of molded insulating brick. The temperature of the inside face of the silica brick is 2550°F.

[2] For future work of this kind the use of Pt Pt-Rh couple is recommended.

Thermal resistance $11^1/_2$-in. silica brick B.t.u.	1.15
Same $2^1/_2$-in. calcined diatomaceous earth brick	1.25
Total thermal resistance	2.40

Assume an outside temperature of 375°F then

Loss B.t.u. per sq. ft. per hr. (Fig. 2)	900
Temperature drop through silica and insulating brick 900 by 2.4 =	2160
Assumed temperature outside	375
Resulting temperature inside	2535

This is close enough to the actual temperature to corroborate the assumed outside temperature.

Temperature drop through the silica brick (900 by 1.15) from 2550 to 1515°F	1035°
Temperature drop through insulating brick from 1515 to 390°F	1125°

So-called super insulating brick are now offered which, it is claimed, can stand 2500°F, will not spall and has a mean conductivity $K = 1.75$ (Eng. units) in the temperature range prevailing on the furnace roof. The following calculations show the heat loss through the furnace roof when insulated with $4^1/_2$ inches of these modern high-temperature insulating brick.

Thermal resistance silica brick B.t.u.	1.15
Same $4^1/_2$ in. high-temperature insulating brick 4.5 by 1/1.75 =	2.57
Total resistance	3.72
Assume outside temperature 300°F then by Fig. 2 loss in B.t.u. per sq. ft. per hr.	600
Temperature drop through silica brick and insulating brick 600 by 3.72	2230
Assumed temperature outside	300
Resulting temperature inside	2530

This is a close enough check to the actual temperature to corroborate the assumed outside temperature.

This shows that $4^1/_2$ inches of the high-temperature brick has practically the same insulating effect as $2^1/_4$ inches of powdered diatomaceous earth. The saving effected as a result of insulation is about 900 B.t.u. per sq. ft. per hr. of roof surface.

Economic Saving

Per 1000 sq. ft. of roof the hourly saving is	900,000 B.t.u.
Yearly value at 20¢ per million B.t.u.	$1580.00
Number of brick on edge required to cover 1000 sq. ft.	6400
Approximate cost in place	$1100.00

This shows a large saving relative to the investment which will be a real saving in all cases where the life of the roof is not shortened. The described method of test can be employed to determine the immediate effect of insulation and, if there is any doubt of remote effects, insulation can be installed on a portion of a roof or on the roof of a small furnace until a satisfactory demonstration for or against its ultimate profit has been made.

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TERRA COTTA KILN SLAB INVESTIGATION[1]

By R. L. Clare, G. H. Brown, and F. B. Allen[2]

ABSTRACT

Following several discussions as to the constitution of a good kiln slab for terra cotta manufacture, a coöperative test was made in which slabs of various compositions were manufactured by a producer of refractories, tested under actual service conditions, and physical measurements were determined by the Ceramic Department, Rutgers University. Series included the use of tight-firing medium refractory clays, open-firing refractory clays with grog, both vitreous and porous. Grogs were sized (definite proportions of size ranges constituting the different members). Conclusions were drawn as to effect of all these variables.

Introduction

In former papers[2] Mr. Clare emphasized the uncertainty as to the constitution of a good slab, the variation in the performance of slabs from manufacturers, and the need of definite knowledge of the qualities required, and also of satisfactory tests therefor. Mr. Allen brought out the fact that variations in performance happened in spite of the manufacturer's efforts to control the conditions under which the slabs are made. He also stressed the need of performance data and methods of determining this data, as a starting point to a slab specification.

Description of Series

The following series were designed, having these variables: (1) Strong clay body (medium refractory); (*a*) hard vitreous grog, (*b*) porous grog, (*c*) grog definitely sized and proportioned. (2) Refractory clay body; (*a*) siliceous grog, (*b*) hard vitreous grog, (*c*) grog definitely sized and proportioned. The clays and grog were furnished by M. D. Valentine and Bro. Co., who also prepared the batches, slabs, and test bars.

The batches were prepared in approximately 3000-lb. lots by the soft-mud process. They were carefully measured, soaked until soft, pugged until they were of uniform texture, and then set aside for two weeks before the slabs were molded. The slabs were pressed by hand in the regular manner. They were carefully dried and fired with the standard slabs of the M. D. Valentine & Bro. Co. in their downdraft kilns at cone 12.

Table I shows the composition of the members of the different series. It shows the clays used, the percentage of grog, and the relative proportions of the different sizes of the grog. Clays 7 and 9 are of medium refractoriness. They fire tight at cone 12 and are used in this series as bonds. Clay 14 is more refractory than either 7 or 9. It is open firing at cone 12. Clay 18 is a No. 1 refractory. It fires to a light buff color

[1] Received Nov. 7, 1928.

[2] Sequel to the papers presented at the Annual Meeting, American Ceramic Society, Atlanta, Ga., Feb., 1926. See *Bull. Amer. Ceram. Soc.*, **9** [9], 358–61 (1926).

at cone 12, where it shows very little warpage. It contains about 15% free sand.

TABLE I
COMPOSITION CHART
(Terra Cotta Kiln Slab Investigation)

Series	Member	Clay 7	Clay 9	Clay 14	Clay 18	Grog	Per cent	Grog sizing 4–8	8–12	12–20	20-D	Spar No. 1	Spar No. 2
A	1	10.50	24.50	35		I	30	9.0	7.5	7.5	6.0		
A	2	9.00	21.00	30		I	40	12.0	10.0	10.0	8.0		
A	3	7.50	17.50	25		I	50	15.0	12.5	12.5	10.0		
A	4	6.00	14.00	20		I	60	18.0	15.0	15.0	12.0		
A	5	9.00	21.00	30		II	40	13.3	13.3	13.3			
A	6	7.50	17.50	25		II	50	16.6	16.7	16.7			
A	7	9.00	21.00	30		III	40			20.0	20.0		
A	8	7.50	17.50	25		III	50			25.0	25.0		
B	1				70.0	V	30					15.0	15.0
B	2				60.0	V	40					20.0	20.0
B	3				50.0	V	50					25.0	25.0
B	4				60.0	I	40	12.0	10.0	10.0	8.0		
B	5				50.0	I	50	15.0	12.5	12.5	10.0		
E	1	9.00	21.00	30		VI	40						
E	2	7.50	17.50	25		VI	50						
E	3	9.00	21.00	30		VII	40						

The Grog Grogs I, II, III are composed of equal parts of Clays 9 and 14. They differ from each other only in sizing.

These three grogs were prepared in the following manner. Two hundred wheelbarrow loads were tempered by the pit wheel method. From this batch 9-inch blanks were made on a soft-mud brick machine. These blanks were then dried and fired to cone 12 after which they were ground and screened as follows: (1) through 4-mesh, held on 8-mesh
(2) " 8 " " " 12 "
(3) " 12 " " " 20 "
(4) " 20 " to dust

These grogs were then mixed thus:

	4 to 8 (%)	8 to 12 (%)	12 to 20 (%)	20 to dust (%)
Grog I	30	25	25	20
Grog II	33⅓	33⅓	33	
Grog III			50	50

Grog I is a mixture of various sizes. It contains some coarse and some fine, but not excessive amounts of either. It contains the widest range in sizing. Grog II contains no fine material. It ranges from 4- to 20-mesh. Grog III contains no coarse material. It is all finer than 12-mesh.

Grog V was composed of equal parts of Spars 1 and 2.* These differ from each other in the size of the quartz pebbles and in the proportion

* This name "spar" is not to be confused with feldspar. It is a locally occurring deposit and consists of rather coarse quartz pebbles bound together with a clay of high refractoriness.

of clay present. Spar 1 is coarser and contains more clay than Spar 2. This grog is therefore much more siliceous than any of the others.

Grog VI was M. D. Valentine & Bro. Company's regular grog sized according to Grog III for comparative data. This grog is composed of their own brick bats and scrap. It is more refractory than Grogs I, II, and III and is also more siliceous.

Grog VII is M. D. Valentine & Bro. Company's regular grog sized according to their standard screens. This grog ranges in size from 4-mesh to dust.

Firing From each batch 12 to 15 terra cotta kiln slabs, two hundred 1- by 1- by 8-inch test bars and about 12 little cones for thermal expansion testing were made. The slabs and 100 test bars were forwarded to the Federal Terra Cotta Co., where the slabs became a part of the kiln equipment. In general these slabs were placed in the lower part of the kiln. The test bars were placed in saggers and after each firing, five were withdrawn from each mixture and sent to the Department of Ceramics at Rutgers. Here they were tested for absorption and cross-breaking strength. The reason for sending the bars after each firing was to find out whether these bodies developed any fatigue. In the event that such a condition arose it was desired to determine how many firings could be safely expected and also to correlate this fatigue with the performance of the slabs.

Results

Table II shows the number of test slabs received originally at the Federal Terra Cotta Co., the number of slabs failed to Dec. 31, 1927, the number of firings at that date, and the estimated life of each mixture. This estimated life is calculated first by assuming that the rate of loss is a straight line. If this is true (and it is approximately), then by dividing the total firings by the number of failures, the firings per slab are obtained. This quotient multiplied by the total of slabs received will give the total firings to be expected. The mean or one-half of this result is the estimated life. This figure may not be strictly correct, but it gives a result sufficiently accurate for comparative data.

TABLE II

PERFORMANCE CHART

Mix	Test pieces	Failed to 12/31/27	Number remaining	Total firings	Estimated life	Mix	Test pieces	Failed to 12/31/27	Number remaining	Total firings	Estimated life
A-1	14	10	4	21	15	*B*-1	0	0	0	0	0
A-2	13	11	2	21	13	*B*-2	12	12	0	7	4
A-3	12	12	0	18	9	*B*-3	12	12	0	4	2
A-4	12	10	2	19	11	*B*-4	14	7	7	13	13
A-5	13	11	2	19	11	*B*-5	12	6	6	14	14
A-6	12	9	3	19	13	*E*-1	12	11	1	27	11
A-7	15	12	3	19	12	*E*-2	12	12	0	10	5
A-8	12	10	2	18	11	*E*-3	7	7	0	12	6

Figure 1 shows the rate of failure of representative mixtures. The 40% grog content members were chosen for this illustration. The short life of the siliceous grog member *B*-2 is clearly shown. The slope of *A*-2 is the most uniform of the lot. Both *A*-2 and *A*-5 are decidedly longer lived than *A*-7, the fine grog member. There is a considerable variation from a straight line rate of failure. But when it is considered that the slabs of necessity failed in units and that they were fired periodically and not continuously, this variation is not so serious. It is therefore believed that the method of estimating the "life" is warranted.

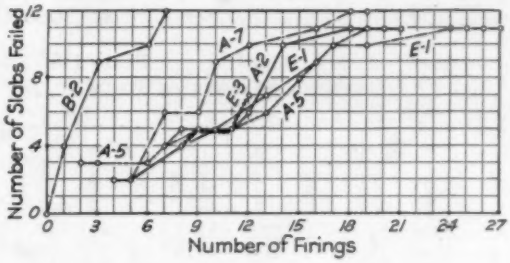

FIG. 1.

Table III shows the changes in the modulus of rupture and absorption with each firing of the trial bars. Both determinations are averages of these values derived from five specimens. Mixtures composed of dense firing clays and grog of the widest range in size (*i.e.*, Series *A*) are the strongest mechanically. But in this series there is a drop in cross-breaking strength, as the proportion of the grog increases. Mixtures containing neither coarse nor fine grog are not as strong as the mixtures containing them. In view of the fact that clays generally give moduli of rupture of greater value with the increase of temperature,[3] slab mixtures having high initial strength will be stronger under fire. They will also stand the usual rough handling better and will last longer in service.

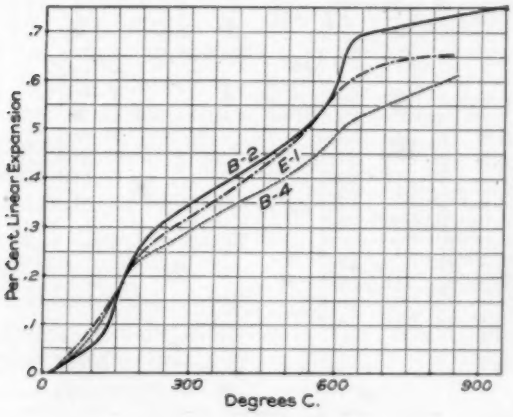

FIG. 2.

Figure 2 plots the fluctuation in the transverse strength and absorption with the firings. No change is seen which would

[3] R. A. Heindl, "IV. Progress Report on Investigation of Sagger Clays, Their Elasticity, Transverse Strength, and Plastic Flow at 1000°C," *Jour. Amer. Ceram. Soc.*, **10** [12], 995–1004 (1927).

indicate any fatigue in the number of firings to which these trials were subjected.

The curves in Fig. 3 show the change in the thermal coefficient of expansion from normal temperature to 1000°C. They are all character-

TABLE III

REFIRING, TRANSVERSE STRENGTH, AND ABSORPTION DATA

A-1			*A*-2			*A*-3			*A*-4			*A*-5		
Firing	Modulus	Absorption (%)	Firing	Modulus	Absorption (%)	Firing	Modulus	Absorption (%)	Firing	Modulus	Absorption (%)	Firing	Modulus	Absorption (%)
1	1668	14.5	1	1151	14.7	1	821	15.1	1	642	19.1	1	890	18.6
2	1645	15.6	2	1010	17.9	2	782	18.9	2	621	18.7	2	779	19.1
3	1656	15.3	3	1105	17.5	3	815	18.9	3	658	18.9	3	785	18.8
4	1859	15.4	4	1010	17.8	4	766	18.6	4	646	18.8	4	820	19.0
5	1658	15.3	5	1029	18.1	5	844	18.5	5	670	18.6	5	816	17.8
6	1835	15.2	6	1056	18.3	6	837	17.3	6	565	18.2	6	940	16.1
7			7			7	885	16.1	7	756	17.9	7	899	17.9
8	1842	14.5	8	1213	16.8	8	854	17.8	8	692	18.2	8	755	17.9
9	1603	14.4	9	981	17.3	9	686	17.4	9	703	17.7	9	902	16.2
10	1657	14.8	10	1153	17.1	10	811	17.5	10	673	18.3	10	794	18.9
11	1678	14.5	11	1221	17.0	11	881	17.3	11	676	18.2	11	681	18.0
12	1700	14.1	12	1148	16.8	12	777	18.0	12	653	18.1	12	853	18.3
13	1541	14.4	13	1061	13.3	13	633	17.8	13	469	18.3	13	900	18.3
14	1655	14.3	14	1022	16.9	14	746	17.8	14	686	17.6			
15	1584	14.6	15	924	17.7									
16	1467	14.3	16	1083	17.3									

A-6			*A*-7			*A*-8			*B*-1			*B*-2		
Firing	Modulus	Absorption (%)	Firing	Modulus	Absorption (%)	Firing	Modulus	Absorption (%)	Firing	Modulus	Absorption (%)	Firing	Modulus	Absorption (%)
1	820	18.4	1	1217	17.6	1	770	18.2	1	886	17.8	1	834	17.1
2	888	18.4	2	1309	17.1	2						2	755	17.4
3	910	18.4	3	1272	17.8	3	825	18.1				3	893	17.1
4	860	19.5	4			4	798	18.1				4	617	17.8
5	952	18.2	5	1628	15.6	5	842	18.0				5	688	17.6
6	878	18.1	6	1259	17.2	6	824	18.3				6	752	17.8
7	928	18.3	7	1394	17.2	7	751	18.3				7	628	17.8
8	826	18.3	8	1178	17.6	8	847	18.4						
9	769	18.0	9	1216	17.2	9	799	18.6						
10	808	17.9	10	1263	17.3	10	720	18.5						
11	838	17.9	11	1167	17.3	11	803	18.7						
			12	1218	17.3	12	712	18.6						
			13	1287	18.1	13	753	18.6						
			14	1210	17.8	14	766	18.7						
			15	1242	17.8									
			16	1224	17.7									

B-3			*B*-4			*B*-5			*E*-1			*E*-2		
Firing	Modulus	Absorption (%)	Firing	Modulus	Absorption (%)	Firing	Modulus	Absorption (%)	Firing	Modulus	Absorption (%)	Firing	Modulus	Absorption (%)
1	33.8	18.4	1	1030	19.9	1	953	18.9	1	1085	16.9	1	872	17.9
2	75.9	18.3	2	1105	20.0	2	568	19.1	2	1074	16.8	2	1066	17.2
3	92.1	18.2	3	1176	19.8	3	871	20.1	3	1202	16.9	3	1008	17.2
4	89.0	18.6	4	1052	19.0	4	858	19.1	4	1191	16.7	4	999	17.5

5	90.0	18.1	5	1178	19.7	5	1226	19.0	5	1095	17.1	5	1074	17.9
6	94.0	18.2	6	1018	19.3	6			6	1186	17.2	6	1059	17.4
7	94.0	18.3	7	997	19.1	7	1011	19.1	7	1142	17.1	7		
8	94.0	18.3	8	1025	19.2	8	863	19.0	8	1110	17.2	8		
						9	950	19.0	9	1216	17.0	9	953	17.3
						10	960	18.6	10	1095	17.0	10	1086	16.7
									11	1113	16.8	11	1027	17.2
									12	1151	16.2	12	948	17.1
									13	1142	15.9	13	1100	17.2
									14	1079	16.2	14	933	17.6
									15	1122	16.5	15	1040	17.3

E-3			*E-4*			*E-5*		
Firing	Modulus	Absorption (%)	Firing	Modulus	Absorption (%)	Firing	Modulus	Absorption (%)
1	488	17.9	2	1105	20.0	1	532	19.4
2	475	18.1	3	1176	19.8	2	544	18.7
3	553	18.2	4	1052	19.0	3	507	19.1
4	506	18.2	5	1178	19.7	4	562	19.0
5	462	18.0	6	1018	19.3	5	518	18.7
6	429	18.4	7	997	19.1	6	580	19.3
7	378	18.2	8	1025	19.2	14	477	19.1
8	561	18.2				15	522	19.2
9	519	17.8						
10	446	18.2						
11	506	18.2						
12	463	16.7						
13	449	17.9						

istic of New Jersey clays, showing well-defined silica inversion points. These curves indicate that the mixtures were siliceous. They also explain the quick failure of the *B* series mixtures. These mixtures varied from each other in the amount of free silica present.

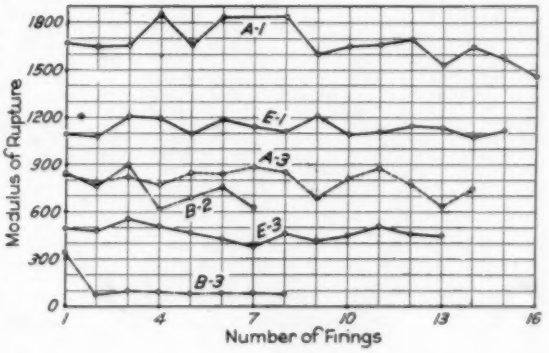

FIG. 3.

Character of Failures

In a large series of this kind, it was impossible to observe all failures. In general, the slabs failed by cracking across the middle, which was largely induced by rough handling. These slabs were fired in the lower part of the kiln so that they were probably under greater strain than slabs higher up in the setting. Undoubtedly the lack of uniformity in texture due to method of manufacture had some effect on the performance. It is difficult to understand why in a lot of fifteen slabs some will fail in two or three firings, while others will last more than twenty.

Conclusions

These conclusions are based on the foregoing experimental work taken as a whole. They are not drawn from the performance of the slabs entirely.

(1) Grog of wide variation in size produces a slab of long life and high mechanical strength. This type of grog gives better service than those types in which there is neither coarse nor fine material.

(2) Vitreous and porous grogs render almost equal service. Vitreous grog produces a mechanically stronger slab, while the porous grog gives a little longer life.

(3) Aluminous vitreous grog gives better service than highly siliceous grog.

(4) High initial mechanical strength is indicative of long kiln life.

(5) As far as covered by the number of firings in this work, there is not sufficient data to indicate either an increase or decrease in strength of a magnitude to warrant any conclusion.

FEDERAL TERRA COTTA COMPANY
WOODBRIDGE, NEW JERSEY

CERAMIC ABSTRACTS

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[1] The abbreviation (*C. A.*) at the end of an abstract indicates that it was obtained from *Chemical Abstracts* by coöperative agreement.

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Abrasives

Simplification for coated abrasive products. ANON. Bur. Stand., *Simplified Practice Recommendation*, No. 89 (1928).—This report lists all present varieties which were reduced from the original 8000 sizes of paper, cloth, rolls, etc., to 1976, an elimination of 75%. This simplified list of sizes will afford a great convenience and saving. R.A.H.

Intensive production assured by efficient abrasive equipment. FRED B. JACOBS. *Abrasive Ind.*, 9 [11], 287–89 (1928).—Production grinding as followed in the manufacture of modern automobile parts necessitates a high degree of accuracy and intensive production. An excellent example of finishing cylindrical work with a wide-faced wheel is the rear axle shaft and in the present instance the work consists of finishing the tapered end that locates in the wheel hub. Considerable care must be exercised in this operation. The Norton grinding machine used in this operation is capable of accommodating work 10 in. in diameter and 32 in. long. It is fitted with a manufactured alumina wheel, 20-in. diameter, $5^1/_2$-in. face, 36 grit, N grade, operated at about a peripheral travel of 6000 ft. per min. The work is located between centers and run at a speed of 18 ft. per minute. The ground portion is $4^1/_4$ in. long, 1.312 in. at the large end, with a taper of 1 in. per ft. E.P.R.

Causes of chatter marks explained. HOWARD W. DUNBAR. *Abrasive Ind.*, 9, [11], 290–91 (1928).—Reprinted from *Grits and Grinds* (Norton Co.). There is a common belief among users of grinding machines that, invariably, chatter marks are caused by gearing in the headstock, but this is rarely true. A list and discussion of about twenty-five different reasons for chatter are given, of which a few of the more important ones are: (1) improper speed relation between wheel and work, (2) improper use of and not sufficient number of steadyrests, (3) vibration of steadyrest shoes because they are loose in the holders, (4) uneven thickness of the belt driving the work, (5) improperly trued wheels, and (6) poorly fitted or loose centers. E.P.R.

Production grinding of pistons and piston pins. ANON. *Abrasive Ind.*, 9 [11], 296–98 (1928).—With an annual production of some 30,000,000 each of pistons and piston pins in the U.S., these industries are important ones and depend solely on precision grinding for intensive production. The up-to-date operations in grinding followed in their production are described and discussed. E.P.R.

Aluminum polishing suggestions. ANDREW V. RE. *Abrasive Ind.*, 9 [11], 298–99 (1928).—The successful polishing and buffing of aluminum is not a difficult procedure if due care is exercised in the selection of wheels and abrasives. The wheel should be in good running balance otherwise it will wear the bearings and not cut evenly. Polishing wheels can be balanced on level balancing ways or on the rotary type of balancing machine. Both types are in common use. Nos. 60, 80, 120, and 150 emery are used ordinarily in polishing aluminum. Four operations may seem excessive but it is better than having to remove emery marks with a buff in cases where the work has been put over only two or three wheels. After the parts have been put over the grease wheel, they are ready for the cutting down by buffing. A good grade of full disk buff should be used. By crossing the work, *i.e.*, by polishing up and down and then at a 45° angle, cutting down can be performed very rapidly. The wheels should not be allowed to become coated or glassy. Kerosene oil applied in small amounts to the cutting down buffs will eliminate this. Kerosene also acts as a lubricant for the wheels. E.P.R.

Carborundum warehouse in Detroit. ANON. *Abrasive Ind.*, 9 [11], 299 (1928).—A general warehouse and district sales office building is being erected by the Carborundum Co. in Detroit at East Grand boulevard, and the Michigan Central tracks facing the boulevard on the tract recently purchased by the Carborundum Co. E.P.R.

Wear testing of various types of steels. J. M. BLAKE. *Abrasive Ind.*, 9 [11],

300–302 (1928).—At a recent meeting of the A.S.T.M. the apparatus developed to test the resistance of metals to abrasion under so-called "wet-grinding" conditions was described. In principle, the machine is a very accurately controlled grinding machine in which all conditions as to abrasive, pressure, speed, time, and moisture or other liquid content are under the control of the operator. It is possible to approximate any given set of field conditions or requirements. The wear is measured by the amount of metal worn off in about 15,000 ft. of travel at a speed of 125 ft. per min., using a pressure of 50 lbs. per sq. in. on a testing face of about 3 sq. in. and is expressed as the ratio of wear loss as compared with a standard (commercially pure iron) at 100. By varying the abrasive used, it has been possible to develop alloys specifically adapted to particular field requirements. E.P.R.

Grinding wheel truing data. ANON. *Abrasive Ind.*, 9 [11], 302–303 (1928).—An abstract of a booklet, "Diamonds for Industrial Purposes," issued by the Selma Mercantile Corp., N. Y. As far as known all diamonds are of volcanic origin. Only in South America are they found on the site of their formation. Elsewhere in the world they are recovered from alluvial deposits in the neighborhood of river beds and the sites of former river systems. The diamond consists of pure carbon and it burns in oxygen at a temperature of about 770°C, forming carbonic acid gas. The diamond is insoluble in acids and alkalis. It crystallizes in regular tetrahedrons of various forms, but it is mostly recovered as an octahedron with rounded edges, frequently also as a duodecahedron with curved facets and in twin formation. It is the hardest of all known substances and has a specific gravity of 3.5 to 3.52, occurring in a wide range of colors. It has a high refractive index. When exposed to radio-active influences a diamond becomes phosphorescent. This is of great practical value as it provides a means of distinguishing it from substances of similar appearance, such as rock crystals, topaz, glass, etc. Diamonds are recovered by washing and special flotation processes. Stones unsuited for gems are used for industrial purposes. There are three distinct groups of industrial diamonds: carbons, bort, and ballas. Carbons are a porous cluster of minute diamond crystals fine to close grained. Bort stones are more or less transparent crystals of white appearance occurring in varied shapes and sometimes in twin and multiple crystal forms. Ballas diamonds are very rare as compared with other diamonds. They are nonporous, round in shape, and consist of innumerable well-formed minute crystals grouped in concentrical formation around a nucleus. Highly finished accurate grinding is possible only with a grinding wheel of nearly perfect cylindrical shape. This is the reason that diamonds have become almost indispensable in modern grinding practice. The diamonds generally used for this work are cape and Brazilian bort and ballas, but the use of carbons for wheel truing is becoming recognized. The extreme long life of the carbon diamond and the fact that they can be used until consumed makes them economical. The most desirable shape of bort stone for truing is an octahedron which may be reset from six to eight times. Usually stones of less than $^1/_8$ carat should not be used for grinding wheel truing, for after they are reduced in size by wear there is difficulty in resetting them securely. The advantage of using stones of the best quality cannot be over-emphasized as they stand up well and wear slowly. The essential factors governing the choice of size of diamonds for grinding are the grade, face, width, and the diameter of the wheel. In truing grinding wheels on precision machines, the truing tool should be held rigidly by mechanical means. Very light cuts should always be taken and to this end the diamond should first be brought in contact with the high points on the wheel, not the edges, and passed slowly across the face of the wheel. A liberal stream of water should be run on the diamond while in use. E.P.R.

Precision thread grinding machine. ANON. *Abrasive Ind.*, 9 [11], 312–13 (1928).—

The Societe Genevoise d'Instruments de Physique, Geneva, Switzerland, is marketing a new high precision thread grinding machine, the Filor, which differs in many respects from the other type of thread grinding machine made by the same firm. The new machine is essentially a tool for the production grinding of thread gages, taps, hardened worms, micrometer screws, etc., for which the highest possible accuracy of pitch, diameter, and profile of thread is required. E.P.R.

Upland diamond deposits of Diamantina district, Brazil. LESTER S. THOMSON. *Econ. Geol.*, **23** [7], 705–23 (1928).—The oldest and most important diamond field of Brazil, thus far discovered, is that of Diamantina, in the state of Minas Geraes. Diamonds are found widely scattered over an area from 30 to 50 kilometers wide. Most of the production has been obtained from alluvial deposits formed by the numerous present drainage systems. Deposits of this class are the most numerous and probably the richest worked to date. The distribution affords a clue to the geographical location of the probable sources. The stones are usually small, the average ranging from $^1/_{10}$ to $^1/_2$ carat in the various deposits. A considerable number, however, weigh from 1 to 4 carats each and 10 carats are not uncommon. The color is a good blue-white. The stones are of excellent gem quality, and generally only 2 or 3% are unfit for cutting. They are said to exhibit a toughness not known in African gems. The crystallization is fairly regular, octahedral forms predominating. In many cases, the faces of the crystals approximate spherical rather than plane figures. This is noticeable even among the octahedra, and many of the higher forms are almost perfect spheres. E.P.R.

Abrasive products of Canada: technology and application. I. Siliceous abrasives. V. L. EARDLEY-WILMOT. Canada Dept. of Mines, *Pub.*, No. 673, 119 pp.—The abrasive uses and the common forms of silica are briefly tabulated.

Abrasive uses	Types of silica used
Grindstones, pulpstones, and sharpening stones	Massive sandstone from very fine to moderately coarse-grained
Tube-mill grinding pebbles	Rounded flint pebbles
Tube-mill lining	Chert, flint, and quartzite in dense solid blocks
Sandblast work	Quartz, quartzite, sandstone, and sand crushed into grains of uniform size
Sawing and polishing marble, granite, etc.	Sharp, clean sand graded into various sizes
Sandpaper	Quartz, quartzite, flint, sandstone, and sand coarsely ground and sized
Lithographers' graining sand	Medium to fine sand or coarsely ground silica and tripoli
Wood polishing and finishing	All forms of silica ground to medium fineness
Scouring and polishing soaps and powders	Quartz, quartzite, flint, chert, sandstone, sand tripoli, and diatomaceous earth, finely ground
Metal buffing, burnishing, and polishing	Ground tripoli and other forms of ground silica
Tooth powders and pastes	Various forms of pure silica, finely ground

The following abrasives are treated in detail as to qualifications required, quarrying and manufacturing methods, general market situation, localities from which produced, and uses: grindstones, pulpstones, burrstones, millstones, chaser stones, grinding pebbles, sharpening stones, flint, quartz and quartzite, chert, hornstone, novaculite, sandstone and sand, diatomite, tripoli and amorphous silica, silt, rottenstone, and clay. A complete bibliography is given after each subdivision of these siliceous abrasives. L.P.C.

Abrasive products of Canada: technology and application. II. Corundum and diamond. V. L. EARDLEY-WILMOT. Canada Dept. of Mines, *Pub.*, No. 675, 51 pp.—

Corundum, an oxide of aluminum, is, with the exception of diamond, the hardest mineral known. It has been used commercially for abrasive purposes only during the last century. Corundum is generally classified into 3 groups: (1) sapphire or gem group which includes all of the transparent varieties suitable for cutting; (2) common corundum which includes all of the opaque varieties and is subdivided into 3 groups: (*a*) block corundum, (*b*) crystal corundum, (*c*) sand corundum; (3) emery which is an intimate mixture of granular corundum and iron oxides. Corundum varies widely in color and the luster is adamantine to vitreous and in some cases pearly. It crystallizes in the rhombohedral division of the hexagonal system. Its specific gravity varies from 4.10 to 3.93. It is used principally for gems, watch jewels, and abrasives. For the latter it is used in 3 forms, grain corundum, abrasive paper or cloth, and in solid forms such as wheels, sharpening stones, etc. Corundum occurs in about 20 kinds of rocks and in about 30 different countries throughout the world. The countries having deposits of commercial importance are, mainly, Canada, U. S., Union of South Africa, India, Madagascar, and Russia. A history of the industry and a description of occurrences in various countries is followed by an outline of the methods of separation and concentration. Emery is produced in the U.S., Greece, and Turkey. It is largely used in the form of loose grain. The crude grain is crushed in jaw crushers and then passed through a series of rolls, after which it falls down a chute and an uprushing current of air blows the mica to one side in a separate compartment. It is then graded in about 30 different sizes. Diamonds are found in both transparent and opaque varieties. The former is used for gems and the latter for abrasive purposes. The principal abrasive uses are in the tips of rock drill bits, in tools for turning abrasive wheels as teeth in saws for cutting rocks, in machine tools for turning hard rubber, fiber paper rolls, brass, bronze, etc., and in tools for glass cutting. About 80% of the world's diamonds comes from the Union of South Africa and the remainder from Brazil, India and Southwest African Protectorate. L.P.C.

Abrasive products of Canada: Technology and application. III. Garnet. V. L. EARDLEY-WILMOT. Canada Dept. of Mines, *Pub.*, No. 677, 69 pp.; for abstract see *Ceram. Abs.*, **6** [12], 553 (1927). L.P.C.

Polish recipes for aluminum. O. G. STYRIE. *Centralblatt der Hütten u. Walzwerke*, **32** [11], 174 (1928).—Cast aluminum is generally rough polished on silicon-carbide wheels. For finish polishing an abrasive consisting of a mixture of one part oil, one part hard stearin, and three parts 180-mesh silicon carbide has been found satisfactory. To obtain shiny surfaces polishes composed of Vienna limestone, mixed with stearin and polishing oil, or tripoli, chalk, rouge, and fullers' earth mixed with oil of turpentine or vaseline, are used. Some tested polishes, which are used especially for aluminum pots and dishes, are as follows:

	(1)	(2)	(3)	(4)	(5)
Barite	6				
Red chalk	2	2		0.1	
Quartzite or pumice		7			
Montan wax	1.6	1.5		0.45	
Vienna limestone	11	11		8	
Dark vaseline	5	5		2.9	4
Tripoli			6		18
Fullers' earth			1.4		
Stearin				0.25	3
Stearic acid			0.8		
Oil of kerosene			0.5		

Polishes 4 and 5 are only for very high polish and are uneconomical for any preliminary polishing. Use of the tumbling barrel for polishing small aluminum ware is discussed.

For mat polishing, a steel wire brush or polishing wheel and powdered pumice or prepared chalk pastes are used. For etching, aluminum, hydrochloride, and hydrofluoric acids are used. Methods of obtaining various types of finishes are described. E.J.V.

Nature of abrasive action. L. WRIGHT. *Chem. and Ind.*, **47**, 1154 (1928).—The extent to which an abrasive medium will wear or cut away the material to be finished depends upon several factors: (1) hardness and structure of the abrasive, (2) pressure at which it is applied, (3) hardness of the material to be removed, and (4) freedom with which abraded particles and useless abrasive can fall away. The abrasive particles must fracture with sharp edges, otherwise the medium is costly and inefficient. A factor not usually considered is the enormous heat developed by the friction; this heat is much greater than is generally known. H.H.S.

Corundum. C. J. N. JOURDAN. *Jour. Chem. Met. Mining Soc. S. Africa*, **28**, 230–36 (1928).—In the north of the Union of S. Africa the corundum fields have an area of 2000 sq. miles. A typical analysis of S. African corundum is: Al_2O_3 94.51, SiO_2 1.54, Fe_2O_3 1.23, TiO_2 0.02, combined H_2O 2.70%. Analyses of bauxites from France and the U.S. are given. The average corundum content of the Transvaal reef ore is "probably somewhere near 40%." A plea is made for developing the deposits in S. Africa. (*C. A.*)

PATENTS

Machine for grinding fluted tools. BENGT M. W. HANSON. U. S. 1,687,725, Oct. 16, 1928. In a machine of the character described, a frame having a bearing, a support having a stem mounted for turning and vertical movements in the bearing, a work holder on the support, a fixed post below the bearing, a screw supported for turning movement on the fixed post, means for turning the screw, a nut on the screw rotatably supporting the stem, and an index scale between the stem and bearing for indicating the angular position of adjustment of the support.

Work rest and ejecting device for grinding machines. WALTER D. ARCHEA. U. S. 1,688,103, Oct. 16, 1928. Attachment for grinding machines, comprising a standard, a work-rest carried thereby, a guideway also carried by the standard; a rod supported and guided in the guideway and provided with a head or bunter, a block carried by and adjustable upon the rod, a lever fulcrumed in a support carried by the standard and having elongated openings at its ends; an actuating-rod carried and guided in supports upon the standard; a laterally-projecting arm carried by one end of the actuating-rod and extending into the opening in one end of lever; a pin carried by block and seated in the opening in the opposite end of the lever; and a spring serving to move rod in an outward direction, and to restore the parts to their normal position after manual movement of the rod inwardly and release thereof.

Grinding machine. HENRY K. SPENCER. U. S. 1,689,176, Oct. 23, 1928. In an abrading machine, the combination of an abrading tool, means for supplying fluid to cool the tool and the work and to carry away the material removed by the tool, an annular work-support which rotates about a generally vertical axis, a bearing for the work-support, and a guard encircled by the bearing and protecting it from the fluid and material.

Grinding of gear-wheel teeth. HARRY HALES ASBRIDGE. U. S. 1,689,274, Oct. 30, 1928. In machines for grinding gear-wheel teeth, the combination comprising a single templet arranged in operative connection with the toothed wheel, an abutment with which the templet coöperates, a spring, one end of which acts upon the templet, a cam member which is acted on by the other end of the spring and is movable relatively to the templet, and a second abutment with which the cam member coöperates.

Hydraulic back rest. AMOS P. STEINER. U. S. 1,689,409, Oct. 30, 1928. A hydraulic back rest comprising a casting, multiple cylinders in the casting, a piston and

piston rod in each cylinder, the rod extending beyond the ends of the cylinder, a bearing block on one end of each rod, an adjusting nut on the opposite end of each rod, hydraulic means to force the rods in the direction of the work, mechanical means to force the rods in the opposite direction, and a latch having a roller adapted to be placed between the adjusting nut and the cylinder end to retain the parts in the last mentioned position.

Grinder. MARSDEN C. HUTTO. U. S. 1,689,589, Oct. 30, 1928. In a grinder for truing cylindrical apertures, a hollow body member having a series of longitudinally extending radial slots therein, a series of abrasive holders fitting the slots, means in the body for adjusting the holders radially in the slots, and an abrasive member adjacent each end of each holder providing a tool with a series of abrasive elements in longitudinally spaced relation adapting the same for grinding pairs of spaced apertures in axial alignment.

Grinding apparatus. DEAR TUNG HOY. U. S. 1,689,922, Oct. 30, 1928. A grinding apparatus comprising a casing, a fluid inlet stub in the upper portion of the casing, an outlet stub at the lower portion of the casing, a rotor actuated by fluid passing through the casing, a spindle to which the rotor is secured, one end of the spindle being extended beyond the casing, and a grinding stone mounted on the extended end of the spindle, the peripheral portion of the stone being positioned adjacent the outlet stub, and a lateral orifice in the wall of the outlet stub on its side next to the stone whereby a portion of the fluid passing through the stub is discharged on the stone.

Emery-wheel dresser. ROLAND P. PLACE. U. S. 1,689,930, Oct. 30, 1928. In an emery-wheel dresser, the combination of a holder having side members, a shaft mounted in the side members, a cutter mounted on the shaft, ball bearings between the shaft and cutter, washers on the shaft contacting with the inner ring members of the bearings, and cup-shaped resilient metal washers between the washers and the side members of the holder to automatically adjust the ball bearings.

Grinding machine, grinding wheel, and method of cooling. WALTER B. LEONARD. U. S. 1,689,950, Oct. 30, 1928. In a grinding machine, in combination, a rotating surface grinder comprising a cylindrical ring of substantial depth having a wall of inherently abrasive material having an annular grinding face on one end thereof and having inclosed pockets substantially elliptical in section extending part way across the annular grinding face thereof obliquely to the radial enclosed by the side wall thereof extending upward a substantial distance within the wall thereof and terminating in rounded upper ends, means for moving work arcuately across a portion only of the rotating annular grinding face, and means to project a stream of coolant substantially vertically upwardly into the pockets adjacent the point of departure of the grinding face from the work, whereby cooling pistons of coolant may be rammed into the pockets after the grinding face leaves the work and dropped out before the pockets again reach the work.

Internal grinding machines. CHURCHILL MACHINE TOOL CO., LTD., AND H. H. ASBRIDGE. Brit. 295,920, Oct. 17, 1928. Feed mechanism for an internal or other grinding machine giving a coarse feed and a fine feed consists of a helical face cam rotated intermittently by a ratchet and pawl in contact with a pin on a slide carrying the grinding wheel. The ratchet wheel is turned by hand to start the fine feed, which continues until the 2nd gaps are reached, when the grinding wheel is again withdrawn for removal of the work, the 2nd gap in the cam being deeper than the 1st gap to allow withdrawal of the wheel to a greater extent. A screw and a nut are provided to compensate for wear of, and to suit the diameter of the grinding wheel.

Grinding and polishing glass. PILKINGTON BROS., LTD. Brit. 296,096, Oct. 17, 1928. In the continuous grinding and polishing of glass plates in a machine having

sets of runners each operating with a different grade of abrasive, the abrasives employed in succession are sand, an emery type of abrasive, pumice, and rouge.

Abrasive compositions. CARBORUNDUM CO., LTD. Brit. 296,195, Oct. 24, 1928. Abrasive compositions for grinding metal surfaces consisting essentially of a granulated abrasive and water contain also fullers' earth or bentonite to assist in the formation of a smooth paste. A material preventing evaporation such as glycerine is also added, with or without small additions of organic binders such as corn syrup and preservatives such as cresol. A typical composition consists of 44% fine silicon-carbide grains, 36% water, 7% bentonite, 11% glycerine, and small quantities of corn syrup and cresol solution.

Grinding cylinders. E. C. R. MARKS. Brit. 296,487, Oct. 24, 1928. A machine for grinding cylinders internally consists of a grinding wheel rotating on a stationary axis, and a work table having a planetary motion to move the work in contact with the disk while the direction of any line of the table does not change, means also being provided for adjusting the radius of movement of the table for applying feed or for removal of the work.

Art

International exhibition of ceramic art. ANON. *Amer. Mag. Art*, **19** [11], 602–20 (1928); *Ceram. Ind.*, **11** [5], 450–51 (1928); for abstract see *Ceram. Abs.*, **7** [12], 806 (1928).

Three workers in stained glass. ANNE WEBB KARNAGHAN. *Amer. Mag. Art*, **19** [11], 589–96 (1928).—Stained glass window making has been revived and is an important industry in this country. The aim of the modern worker is to render emotional effects of light transmitted through colored glass. Details are painted in, the paint fusing with the glass when fired. Clarity of design is a fundamental requirement but pictorial effects, since they prevent translucency, are not desirable. The article includes descriptions and illustrations of distinguished modern windows by Reynolds, Francis, and Rohnstock (designer, glass painter, and glazier, respectively) who are contributing largely to the progress of the craft. E.B.H.

Excavating Kish. STEPHEN LANGDON. *Art and Arch.*, **26** [5], 155–68 (1928).—The excavations at Kish in Mesopotamia have yielded valuable productions of the lower strata of the temple mound. In the Red Earth Strata of 2800 B.C. are found specimens of champagne vases and a large jar with handles, on which is represented the mother goddess, Aruru. There was also a good painted pot with only a red wash slip. Beneath the red level are potsherds with red and purple wash. The lower tombs, dated 4000 B.C. reveal painted pottery of high attainment, among them a peculiar type of vase 3 ft. high etched with lozenge designs and having the flat flanged base pierced by a hole. E.B.H.

Modernistic animals in faience. CLAUDE LEVY. *Arts and Dec.*, **30** [1], 54 (1928).—Illustrations of animals done with delightful and humorous simplification at the Alsatian peasant pottery of L. All have strange modernistic lines and color combinations and are causing much favorable comment. E.B.H.

Illustration. ANON. *Design*, **30** [6], 106, 107 (1928).—Illustration of splendid work done by pupils of Syracuse University, Adelaide Alsop-Robineau, instructor. E.B.H.

Potsherds from Choctaw village sites in Mississippi. H. B. COLLINS. *Jour. Wash. Acad. Sci.*, **17** [10], 259–63 (1927).—There is little evidence of Indian culture remaining in the southeastern states except pottery and implements of stone, shell, and bone. The potsherds indicate a definite type of historic Choctaw pottery, entirely distinct from that of any other region. It is of hard, uniform texture, usually tempered

with sand so fine that it can hardly be detected by the unaided eye. Both inner and outer surfaces are smooth and sometimes rather highly polished. The potsherds range from light red and buff through gray into black, the largest proportion being buff or light gray. A few received a slip of light brick red on both surfaces. The vessels appear to have been bowls of medium depth. Decoration was largely confined to the upper part of the vessel and consists of straight or curved bands, made of five or six finely incised lines ranging in width from 5 to 10 mm. The uniform distance between lines and their uniform depth show they were made by a comb-like implement. A few potsherds show free hand decorations. No other well-defined ceramic type is represented in the potsherds from this district. About 20 are of cruder ware and are meagerly ornamented with irregular incised lines. There is comparatively little undecorated ware of a cruder type; the greater part of the plain ware, of which there is much, is of the same smooth compact type as the decorated pieces. The presence of this single type of decorated ware from such widely separated Choctaw settlements, covering the entire area known to have been occupied by that tribe, suggests very strongly that it was the prevailing type of pottery in use at some period of their history. This pottery is similar in texture and color to a type from the mounds in western and central Miss. and in parts of Ark. and La. It is, however, strikingly different from the prevailing type of mound pottery from eastern Miss. which is usually rough and crumbly and contains rather coarse tempering material. The decorations most often found are produced either by brushing or by impressed cords or coarse fabrics on the soft surface. Sometimes there is an ornamentation consisting of carelessly incised lines or punctuations, and, infrequently, of the stamped curvilinear designs common in Ga. and Fla. A.J.M.

Stability of fired decorative colors in glass. ANON. *Diamant*, **50** [13], 276; [16], 331; [17], 356; [18], 378; [19], 394–95; [26], 542–46 (1928).—A series of articles or letters from various stained glass workers and technicians in response to a general questionnaire on the above subject. E.J.V.

Ruby glasses. RAOUL H. FRANCÉ. *Diamant*, **50** [16], 335 (1928).—A brief discussion of the methods and materials used in the production of ruby glasses. E.J.V.

Modern artistic glass. W. E. S. TURNER. *Pottery Gaz.*, **53** [617], 1777–78 (1928).—The development of glassmaking over 30 centuries, from early Egyptian times up to the present day, is rapidly sketched. A high tribute is paid to the lead crystal, of acknowledged purity and brilliance, produced in the Stourbridge district. Colored glass is coming more and more into vogue in the American market and some of the English manufacturers are catering with conspicuously successful results for that demand. For some time many beautiful colors had been incorporated in English crystal glass, mainly as flashings, but there were other adaptations of color to glass that were being developed in certain quarters, embodying waves and splashes of color, in some cases combined with iridescence and even bubbles. Now the whole range of chemical elements is being ransacked by glassmakers in order to introduce new features, new tints, and carry on development work. In Czechoslovakia a feature is being made, not of flashed glass, but stained glass, the result of silver and copper stains. At Leerdam, Holland, some artistic glass was being produced with individual characteristics in color and form combined in the interest of service. E.J.V.

Color scheme machine. ANON. *Ceram. Ind.*, **11** [5], 491 (1928).—A new instrument by which the decorative artist can reach an ideal color scheme is called the Multochrome, operating on the following principle: the various elements of a pattern are photographed separately in such a way that they may be projected in combination under such conditions that each element is entirely under the control as regards color and brightness. F.P.H.

Titanium crystal glazes. SEIJI KONDO. *Jour. Jap. Ceram. Assn.*, **35** [417], 431–58 (1927).—The results of experiments on TiO_2 crystal glazes applied on hard biscuited porcelain tiles are as follows:

Series	K_2O	Na_2O	ZnO	CaO	SiO_2	TiO_2	Good at cone	Remarks
	0.3		0.7		2.0			Range of series I; 21 members
	0.3		0.7		1.5	0.5		
I	0.8		0.2		1.5	0.5		
	0.4		0.6		1.6	0.4	10 to 12	Best glazes in Series I in these ranges
	0.6		0.4		1.7	0.5		
	0.3			0.7	2.0			Range of series II; 21 members
	0.3			0.7	1.0	1.0		
II	0.3		0.7		1.0	1.0		
	0.3		0.42	0.28	1.4	0.6	8	Excellent
	0.3			0.7	1.4	0.6	8	Good
	0.3		0.42	0.28	1.2	0.8	8	Good
	0.2		0.8		2.0			Range of series III; 56 members
	0.8		0.2		2.0			
	0.2		0.8		1.3	0.7		
	0.8		0.2		1.3	0.7		
III	0.2		0.8		1.5	0.5	10 and 12	12 good glazes
	0.6		0.4		1.3	0.7		
	0.3		0.7		1.6	0.4		4 good glazes
								Range of series IV same as III using Na_2O rather than K_2O
		0.3	0.7		1.9	0.1		
		0.2	0.8		1.7	0.3	8, 10 and 12	14 good glazes
		0.4	0.6		1.7	0.3		
IV		0.3	0.7		1.6	0.4		
		0.2	0.8		1.7	0.3		7 good glazes
		0.3	0.7		1.3	0.7		
		0.4	0.6		1.7	0.3		Excellent
								Same as III and IV but with equal parts Na_2O and K_2O
V	0.15	0.15	0.70		1.7	0.3	8, 10 and 12	7 good glazes in this range
	0.15	0.15	0.70		1.5	0.5		
	0.1	0.1	0.8		1.7	0.3		5 good glazes in this range
	0.2	0.2	0.6		1.3	0.7		
	0.15	0.5	0.7		1.7	0.3		Best glaze crystals better than in series IV
	0.15	0.15	0.7		2.0			
	0.15	0.15	0.7		2.0	0.7		Range of series VI
	0.15	0.15	0.7		0.8			
	0.15	0.15	0.7		0.8	0.7		
VI					1.4	0.1		
					1.6	0.2		
					0.8	0.2		
					2.0	0.3	10 and 12	21 good glazes within these ranges
					1.6	0.3		
					1.2	0.3		
					0.8	0.3		
					1.2	0.4		
					0.8	0.4		
					0.8	0.5		
		0.3		0.7	2.0			
		0.3	0.7		1.0	1.0		Range of series VII

Series	K_2O	Na_2O	ZnO	CaO	SiO_2	TiO_2	Good at cone	Remarks
VII		0.3	0.7		1.8	0.2		
		0.3	0.7		1.7	0.3		
		0.3	0.3	0.4	1.6	1.3	8	Good
		0.3	0.3	0.4	1.3	0.7		
		0.3	0.7		1.6	0.4		
		0.3	0.6	0.1	1.5	0.5	10	Good
		0.3	0.7		1.3	0.7		
		0.3	0.6	0.1	1.3	0.7		
		0.3		0.7	1.3	0.7		
		0.3		0.7	1.0	1.0		
		0.3	0.10	0.6	1.4	0.6	12 and 8	Good
		0.3	0.10	0.6	1.2	0.8		
		0.3	0.2	0.5	1.4	0.6		
VIII								Range of VIII same as VII but R = Mg. Good glaze in about same range as in VII, more refractory, more crystals, silver luster
IX								Range of IX same as VII but R = MnO. Range of good crystals at 8 and 12, much less, luster less, crystals more fibrous.

S.K.

Comparative test of liquid golds. BUREAU OF INDUSTRY (Dept. of Com. and Ind.). *Jour. Jap. Ceram. Assn.*, **35** [419], 580–81 (1927).—Properties of 4 liquid golds, *i.e.*, (1) made by the Nippon Kin-eki Co., Ltd., (2) the latest product of the company, (3) imported from America, and (4) made by the Osaka Industrial Laboratory, are compared.

	(1)	(2)	(3)	(4)
Viscosity	Apparently too thick	Suitable	Best	Too fluid for fine lines
Specific gravity	1.170	1.163	1.166	1.178
Content of Au	10.85%	10.96%	10.89%	8.52%
660°C firing	Not firmly fixed or sufficiently brilliant	Same	Same	Same
680°C firing	Firmly fixed and brilliant	Same	Same	Same
700°C firing	Firmly fixed; not sufficiently brilliant	Same	Same	Same
Required to paint 49 sq. cm.	0.1238 g.	0.1268 g.	0.1444 g.	0.1166 g.

Copper ruby glaze. I. TOSAKU YOSHIOKA AND SHO HIRAOKA. *Jour. Jap. Ceram. Assn.*, **35** [420], 608–14 (1927).—The history and literature on the subject are reviewed. Effect of atmosphere on the coloration of Cu in soda-silica glazes is discussed. Coarse grains of frits, Na_2O (1–4) SiO_2, containing 2% CuO were heated in a current of H_2, CO, CO_2, N_2, or O_2 at 600 to 1000°C for 1 hr. with the result that N_2 and CO_2 were most suitable for the production of red. The effect of glaze composition and temperature on the coloration is given as follows: 5 types of frits, *i.e.* (*A*) $0.5Na_2O$, $0.5CaO$, $2.0SiO_2$, $0.5B_2O_3$

(*B*) $0.375Na_2O$, $0.075K_2O$, $0.550CaO$, $0.125Al_2O_3$, $2.5SiO_2$, $0.375B_2O_3$

(*C*) $0.25Na_2O$, $0.15K_2O$, $0.60CaO$, $0.25Al_2O_3$, $3.0SiO_2$, $0.25B_2O_3$

(*D*) $0.125Na_2O$, $0.225K_2O$, $0.650CaO$, $0.375Al_2O_3$, $3.5SiO_2$, $0.125B_2O_3$ and (*E*) $0.3K_2O$, $0.7CaO$, $0.5Al_2O_3.4SiO_2$, each con-

taining 1% CuO with or without 1% As_2O_3, BaO, Fe_2O_3, PbO, SnO_2, or ZnO, were reheated for 1 hr. in an atmosphere of N_2 or CO_2 at 600 to 1200°C. Results: (1) frits of types *A* and *B* are unfit for the production of red; (2) in those frits of type *C* which contain PbO, Fe_2O_3, SnO_2, or ZnO beautiful ruby reds were produced when they had been heated at 800° or better at 700°C, SnO_2 being most suitable in this respect; (3) some grayish reds were obtained with frits *D* and *E;* (4) CO_2 is better than N_2, as it makes the glazes brighter. S.K.

Standard for white. W. T. M. FORBES. *Amer. Jour. Psychol.*, **40,** 522–23 (1928).—The standard of white accepted by studio artists, that of a north sky-light, is too blue, since it comes from a source so obviously blue as the sky. On the other hand, the standard adopted by the Bureau of Standards, the direct light from the noon sun, is too yellow. True white lies between these two values. F. suggests that the best approximation to the true value is the light of a white cloud, illuminated alike by the sun and by the diffuse blue light of the sky. H.H.S.

Romano-British pottery at Springhead, Kent. R. F. JESSUP. *Antiquaries Jour.*, **8,** 337–43 (1928).—The pottery found at Springhead, a former Roman station, was mostly Samian, Hadrianic, Belgic, and Vespasianic, but a kiln for the manufacture of "Upchurch" pottery was cut through, and specimens of pottery were remaining in the kiln, their appearance in color and clean fracture being as new as though they had recently been fired, so well had the brick-earth excluded the air. Illustrated. H.H.S.

Prehistoric Panama pottery. A. H. VERRILL. *Illust. London News,* **173,** 652–55 (1928).—Remarkable colored drawings of pottery from the province of Coclé, Panama, are shown. A prehistoric civilization was suddenly destroyed by earthquake, columns of buildings being broken squarely off and partly tossed about. Of the hundreds of specimens of pottery found, most are of a type hitherto unknown. H.H.S.

Chinese pottery of foreign influence. FRANK DAVIS. *Illust. London News,* **173,** 676 (1928).—As early as the 1st Century B.C., the Chinese court was aware of other countries, received their envoys, and tolerated foreign settlements. Thus ceramic ware came to be made in China which was not of the Chinese type, but ranged in culture-origin from Europe to Japan and as far south as Siam. Illustrated. H.H.S.

Art treasures from Russia. ANON. *Illust. London News,* **173,** 706, 707, 754, 755 (1928).—The Soviet government held on Nov. 6 and 7 its first official art sale at Rudolph Lepke's in Berlin. The sale comprised 447 objects of art from the museums and palaces of Leningrad, including the Hermitage, Michailoff, and Gatchina. In ceramic ware, the sale included terra cotta from the Renaissance to the 18th Century. Illustrated. H.H.S.

Mosaic pavement at Butrinto. L. UGOLINI. *Illust. London News,* **173,** 737 (1928).—The Italian Archaeological Mission to Albania, of which U. is head, has made discoveries of interest at Butrinto, the place where Helenus, son of Priam, built a miniature reproduction of Troy. Successive periods (Venetian, Byzantine, Roman, Greek, and prehistoric) are represented in the finds. The chief Byzantine relic is a baptistry with columns and font amid a finely preserved mosaic pavement. Three photographs. H.H.S.

PATENTS

Ornamental design for plate or similar article. MATTHEW A. HANSE. U. S. 75,974, Aug. 7, 1928.

Design for drinking glass. HALLER H. DAWSON. U. S. 76,668–70 (3 patents), Oct. 23, 1928.

Ornamental design for dish or similar article. WILLIAM P. GRAHAM. U. S. 76,681, Oct. 23, 1928.

Ornamental design for plate or similar article. JOHN A. CRONIN. U. S. 76,778, Nov. 6, 1928.

Ornamental design for plate or similar article. URASABURO TOMITA. U. S. 76,831–42 (12 patents), Nov. 6, 1928.

Cement, Lime, and Plaster

Consistency of silicate of soda for curing concrete. ROBERT S. BEIGHTLER. *Eng. News-Rec.*, **100** [8], 316 (1928).—In Ohio experimental road construction, silicate of soda was applied on basis of density rather than by less accurate method of dilution by volume. Silicate diluted to 35°Bé did not effect as complete a seal of the surface as a 36 to 37°Bé solution. A more effective seal was obtained with the same amount of silicate by protecting the concrete until the day following its laying. Viscosity-density curve for sodium silicate at 78°F is shown. L.A.P.

Lumnite cement. ANON. *Canad. Eng.*, **55,** 30 (1928).—A notice of the Kansas State Agr. College *Bulletin*, on the quick-hardening high-alumina cement known as lumnite. The tests show that lumnite is as resistant to wear after 48 hours as ordinary cement after 60 days. H.H.S.

Action of diatomaceous earth in concrete. ANON. *Eng. Min. Jour.*, **125** [14], 544 (1928).—An extremely small proportion of diatomite has been found effective in preserving the uniformity of the sand and rock distribution in the mix. Less water is required and the ultimate strength is increased. The diatomite apparently aids in the transmission of jars and movements that assist in packing evenly. The voids are lessened in magnitude and greater bonding effect is secured. A.J.M.

Expansion of cement. H. J. RYAN AND J. K. IMOKAWA. *Proc. Nat. Elec. Light Assn.*, **82,** 1612–13 (1925).—The cyclic variations of the volume of cement have been investigated at Stanford Univ. The outstanding features of the results are the relatively large variations in volume found to occur, and the discovery that the volume is not a single valued function of the moisture content of the cement. Expansion curves and tables are given to show results. The explanation of the curves is based on the assumption that the cement contains physical cracks and voids containing air in a dried specimen and that the cementing substances are colloids that, like glue, expand greatly when they absorb moisture. R.G.E.

Trass for cement products. ANON. *Baumarkt*, **27,** 552 (1928); *Rock Prod.*, **31** [21], 106 (1928).—A mixing proportion of 80 weight parts of Portland cement and 25 weight parts of Nettetaler trass in place of 100% cement is recommended. Strength of flexure of the roofing stone exceeds stone of Portland cement alone. Similar results are obtained with 75 weight parts Portland cement and 25 weight parts Nettetaler trass. The use of trass makes the stone more solid. The Nettetaler trass has shown a compressive strength of 230 kg. and tensile strength of 30 kg. F.P.H.

Importance of magnesite for the wood-filled tile industry. ANON. *Baumarkt*, **27,** 905 (1928); *Rock Prod.*, **31** [21], 107 (1928).—The most important organic fillers for caustic magnesite are sawdust and ground wood, and the most important inorganic fillers are principally talcum, infusorial earth, and asbestos, to which colored fillers may be added to suit the wood-filler tile for flooring and other purposes. F.P.H.

Mineral paints. ANON. *Baumarkt*, **27,** 905 (1928); *Rock Prod.*, **31** [22], 101 (1928).—Silicate or mineral paints consist of a color base or binder simulating plaster or other finish in their composition and of specially selected dry colors, this mixture entering into the smallest ducts of the plaster or other finish on the façades of buildings, coloring it inside and outside and securing a surface impermeable to water and assuring longer life by effecting an initimate chemical combination. F.P.H.

Dangers of gypsum in concrete structures. ANON. *Le Ciment*, **33** [5], 203–204 (1928); *Rock Prod.*, **31** [22], 101 (1928).—Sulphuric acid present in concrete combines with aluminate of lime to form gypsum (sulphate of lime), and eventually a double salt, the double sulphate of alumina and lime, a combination of the alum order which absorbs water energetically and as a result causes expansion, fissuring, and scaling of the concrete. The danger of sulphuric acid in concrete is greater in calcareous and alumina cements, so that blast-furnace cement or iron cement, low in alumina content, and especially *ciment fondu* are preferable, whereas Portland cement is rendered resistive by adding trass. The sulphuric acid is likely to enter the concrete in preparing mortar with sulphur-containing water obtained from certain strata in the soil or certain manufacturing districts, or with sulphur-containing sand or gravel as well as by way of unprotected concrete surfaces. F.P.H.

Keystone cement plant. GEORGE M. EARNSHAW. *Rock Prod.*, **31** [21], 50–65 (1928).—Practically all mechanical equipment in the Keystone Portland Cement Co., Bath, Pa., is of a type never before installed in America. The plant is carefully designed and well constructed with many unique features. F.P.H.

American pozzuolana and its effect on Portland cement concrete. LEE HEINDENREICH. *Rock Prod.*, **31** [22], 64–65 (1928).—According to Kühl, the tricalcium aluminates are of special importance as they form trivalent ions and "the ability of ions to form gels and to coagulate them, is dependent on the valence." Tricalcium aluminate cannot exert its coagulation effect on the gradually forming colloidal solution of the calcium silicate, if the $CaSO_4$ present forms an insoluble salt. Alumina will offset this action of gypsum, forming calcium aluminate. According to R. H. Bogue, set is caused by precipitation of the colloidal silicate induced by ions, especially trivalent aluminate ions. Calcium sulphate keeps the ion concentration too low by precipitation of calcium sulpho-aluminate. The addition of pumicite or a pozzuolana, which has a potential tendency to combine its alumina content thus helping offset the gypsum action whether it be a catalytical or electrolytic influence, should result *a priori* in a more complete hydration of the cement, such as has been proved in practice. F.P.H.

Literature on constitution of Portland cement clinker. H. RICHARZ. *Tonind. Ztg.*, **52**, 586–89, 634–37, 1078–81 (1928); *Rock Prod.*, **31** [22], 101 (1928). F.P.H.

Determining lime in raw materials used in production of cement. FRANZ KUBIK. *Tonind. Ztg.*, **52** [34], 678 (1928); *Rock Prod.*, **31** [21], 106 (1928).—One of the most important problems is a homogeneous raw mixture of cement batch. The main concern is the hydraulic index $\frac{CaO}{SiO_2 + R_2O_3}$. The relation between SiO_2, Al_2O_3, Fe_2O_3 is ordinarily not regulated. It is possible to add quartz flour to the raw materials. In the presence of Fe_2O_3 such mixtures sinter easily. For continuous control two methods are in use: (1) titrating with normal hydrochloric acid and $^1/_2$ *N* caustic soda, and (2) the carbonic acid method. K. has used the titrimetric and calcimetric methods for 5 years. In the titrimetric the minimum was 76.4%, the maximum 76.7%, and the average 76.56%; and in the calcimetric method the minimum was 77.1%, the maximum 77.5%, and the average 77.28%. The content of $CaCO_3$ found in the analysis was 76.11% and that of $MgCO_3$ 1.25%. Both exceed the results by 0.45% $CaCO_3$ in the titrimetric and 1.17% $CaCO_3$ in the calcimetric method. The magnesia is important though generally included and given as $CaCO_3$. Many exterior indications evidence the lime content of the raw mixture. A more difficult burning of small grains of clinker, etc., indicates too much lime in the raw mixture. A lower mixture results in deposits (ring formations). The appearance of the clinker differs also according to the $CaCO_3$ content in it. Normal clinker has a black-gray, greenish, or bluish appearance with a

certain opalescence, which originates from the many colorless crystals. A lower mixture gives slaglike dull pieces of clinker. F.P.H.

Start of setting period observed with the vicat needle and setting automat. NITZSCHE. *Tonind. Ztg.*, **52** [51], 1036–37 (1928); *Rock Prod.*, **31** [22], 101 (1928).—N. describes the method and results of comparative tests upon four cements. An increase in temperature accelerates the start of setting and a covering of the vessels containing test samples retards the start of the setting due to a decrease in evaporation. The test results are presented in tables. F.P.H.

Modern problems in the cement field. H. LUFTSCHITZ. *Tonind. Ztg.*, **52** [57], 1158–60 (1928); *Rock Prod.*, **31** [21], 107 (1928).—L. discusses the use of cements of the same kind, but made at different plants or stored in different bins, and also of different types of cement, separately or mixed, possible effects, such as compensation of qualities, and the need for standards for Portland cement, iron Portland cement, blast-furnace cement, and lime in this respect. F.P.H.

Steam-hardening tests for obtaining 28-day strengths in two days. KARL BIEHL. *Zement*, **17** [16], 654–57 (1928); *Rock Prod.*, **31** [22], 100 (1928).—B. produced a gas-fired Pflugbeil steam-generating tank of 52-quart capacity and provided with a safety valve and two manometers, one being a control meter and the other a gas-pressure regulator which permitted adjustment to and maintenance of any desired steam pressure to 735 lb. per sq. in. The tank is described. F.P.H.

Storage and packing of cement. E. C. BLANC. *Zement*, **17** [23], 910 (1928); *Rock. Prod.*, **31** [21], 107 (1928).—B. describes the storage of the finished cement in bins and the equipment which is used in packing the cement. The automatically operating machines such as "Exilor," "Silator," "Bates" machines, and keg packing machines are described in detail. The dust removal plant is also dealt with, including suction hose filters, Pfeiffer cyclones, and the Cottrell and Oski processes of electrical precipitation and dust removal. F.P.H.

Relations between composition and strength of cement mortar on combined hardening. II. SHOICHIRO NAGAI. *Jour. Soc. Chem. Ind., Japan*, **31** [10], 225–26B (1928).—Continuing the study on combined hardening of cement mortars N. calculated the following ratios between the chemical composition of cements and studied the relations between these ratios and strength of mortars on combined hardening (1 day in wet air, 6 days in water, and 21 days in air curing) and on common hardening (1 day in wet air and 27 days in water curing). The results are briefly summarized as follows: (1) Lime silica combining ratio is calculated as follows:

$$(\text{L.S.C.R.}) = \frac{\text{CaO} - (1.65 \times \text{Al}_2\text{O}_3 + 0.70 \times \text{Fe}_2\text{O}_3 + 0.70 \times \text{SO}_3 + \text{free CaO})}{\text{SiO}_2 - 0.80 \times (\text{Insol. res.})}$$

In this ratio, free lime was determined by the method proposed by Lerch and Bogue (*Ceram. Abs.*, **5** [10], 296 (1926)) and the factor (0.80) of insoluble residue of Portland cement is of silica content, which was obtained by analysis of insoluble residue of some Portland cements. This ratio is in linear proportion with the increase of strength of cement mortar on combined hardening to that on common hardening. (2) Calcium silicate ratio and silicate lime ratio are calculated as follows:

$a = \text{CaO} - (1.65 \times \text{Al}_2\text{O}_3 + 0.70 \times \text{Fe}_2\text{O}_3 + 0.70 \times \text{SO}_3 + \text{free CaO})$
b (% of CaO forming $2\text{CaO}\cdot\text{SiO}_2$) $= 2[2.80\ (\text{SiO}_2 - 0.80\ (\text{Insol. res.})) - a]$
c (% of CaO forming $3\text{CaO}\cdot\text{SiO}_2$) $= a - b$
d (% of $2\text{CaO}\cdot\text{SiO}_2$) $= 1.54 \times b$
e (% of $3\text{CaO}\cdot\text{SiO}_2$) $= 1.36 \times c$

$$\text{Calcium silicate ratio (C.S.R.)} = e/d = \frac{3\text{CaO}\cdot\text{SiO}_2}{2\text{CaO}\cdot\text{SiO}_2}$$

$$\text{Silicate lime ratio (S.L.R.)} = c/b = \frac{3\text{CaO}\cdot\text{SiO}_2}{2\text{CaO}\cdot\text{SiO}_2}$$

These ratios are also in close relation with the increase of strength on combined hardening to that on common hardening. Further investigations are being conducted on the longer combined hardening and the effects of siliceous matters mixed with cements on combined hardening. E.J.V.

Test on Japanese cements. II. SHOICHIRO NAGAI. *Jour. Jap. Ceram. Assn.*, **35** [417], 463–72 (1927).—Results of tests on 12 Portland cements, 1 blast-furnace cement, 1 soliditit, made in Japan in April, 1927, and German Velo cement are compared with those of similar tests reported just one year ago.

Strength of 1:3 Mortar in Kg. per Sq. Cm.

	Tensile strength				Compressive strength			
	2d.	3d.	7d.	28d.	2d.	3d.	7d.	28d.
Av. of 8 Jap. Port. cements (1926)	19.7		27.0	33.2	188		338	435
Av. of 12 Jap. Port. cements (1927)		26.7	28.7	32.3		329	437	531
Velo cement		38.1	38.6	37.2		545	571	650
Blast-furnace cement		23.7	26.4	35.0		273	376	537
Soliditit		19.6	21.3	27.5		190	282	460

Residues on standard sieve with 4900 meshes per sq. cm. are: Average of 12 Portland cements 3.04%, Velo cement 1.56%, blast-furnace cement 3.10%, and soliditit 8.25%. S. K.

Tests on Japanese cements. III. SHOICHIRO NAGAI. *Jour. Jap. Ceram. Assn.*, **35** [418], 510–19 (1927).—Japanese standard sand is compared with foreign ones.

TABLE I

Comparative Strengths of 1:3 Mortars (aged 3 to 28 days in kg. per sq. cm.)

	Tensile strength	Compressive strength
Jap. standard sand	100.0	100.0
German " "	97.2	96.0
American " "	103.8	107.2

Analyses of 10 Japanese cements made in the spring of 1926 are given in Table II.

TABLE II

Analysis of Japanese Cements

	Ignition loss	Insol. m.	Silica	Alumina	Ferric oxide
8 Portland cements	0.64–2.88	0.22–0.68	21.58–23.12	5.28–6.02	2.22–3.46
Average	1.42	0.41	22.42	5.55	2.96
Blast-furnace cement	0.30	0.54	27.50	11.32	2.62
Soliditit	1.40	17.14	31.58	5.57	3.51

	Mn oxide	Lime	Magnesia	Sulphuric anhydride	Sulphide	Alkalis
8 Portland cements		64.05–65.38	1.03–1.52	1.10–1.59		
Average		64.82	1.34	1.31		
Blast-furnace cement	1.10	50.27	1.62	1.53	0.62	2.39
Soliditit		53.60	1.42	1.28		1.62

S. K.

History of blast-furnace cement manufacture at Imperial Steel Works. MUNEO TANI. *Jour. Jap. Ceram. Assn.*, **35** [419], 573–79 (1927).—A brief history of the cement manufacture at the Imperial Steel Works, a description of the plant, and the properties of the cement manufactured from 1913 to the present time are given. S.K.

Tensile strength of the mixture of alumina cement and Portland cement. EIZO MIKI. *Jour. Jap. Ceram. Assn.*, **35** [420], 622–23 (1927).—Results obtained from a study of setting time and tensile strength of varying mixtures of a Portland cement and *ciment fondu* or Atlas lumnite cement are given. The mixtures containing 30 to 80% Portland cement set too quickly for ordinary purposes; 20% of the alumina cements can be replaced by the Portland cement without material decrease in their early strength, while small addition of the alumina cements to the Portland cement is injurious.

TABLE I

Tensile Strength of 1:3 Mortars in Kg. per Sq. Cm. (4 to 28°C)

Age	Ciment fondu (10%) Portland cement (90%)	(80%) (20%)	Atlas lumnite cement (10%) Portland cement (90%)	(80%) (20%)	Portland cement
1 day	7.4	44.9	5.3	45.2	18.7
2 days	6.4	53.1	11.0	53.0	
3 days	11.3	53.3	19.8	47.5	35.3
1 week	40.7	39.9	41.2	49.1	48.8
4 weeks	52.2	29.6	52.3	45.1	56.8
13 weeks	59.8	36.3	61.8	49.5	57.1
1 year	52.9	30.4	59.3	46.3	55.2

The 1 d. strength of 1:3 mortars of *ciment fondu* and Atlas lumnite cement are 43.1 and 36.2, respectively. The mixture of 80% Atlas lumnite cement and 20% Portland cement, which retains high strength in higher ages, is quite sound. S.K.

Early strength of cement. I. SHOICHIRO NAGAI. *Jour. Jap. Ceram. Assn.*, **36** [421], 1–11 (1928).—High alumina cements decrease in strength at higher ages while the rate of increase in strength with age is marked in super cements, although it is generally less than in Portland cements. Japanese Portland cements have been abruptly improved in the last 2 or 3 years. N. carried out an investigation to compare 2 foreign high early strength Portland cements (imported in 1927) with 5 Japanese Portland cements, hardening comparatively rapidly and manufactured in 1927. The results are shown in the tables.

TABLE I

Results of Usual Tests

	Sp. gr. after ignition	Residue on sieves (%) 900-mesh	2500-mesh	4900-mesh
(1) Velo cement	3.09	0.19	0.35	1.56
(2) Ferro-concrete	3.21	0.08	0.20	0.64
(3) Jap. Portland cement	3.25	0.22	0.26	1.68
(4) Jap. " "	3.24	0.02	0.74	4.92
(5) Jap. " "	3.24	0.14	0.77	4.71
(6) Jap. " "	3.17	0.06	0.30	0.62
(7) Jap. " "	3.19	0.08	0.36	1.08

TABLE II

Tensile Strength in Kg. per Sq. Cm.

	6 hrs.	12 hrs.	18 hrs.	1 d.	2 d.	3 d.	5 d.	7 d.	28 d.
(1)	4.85	29.9	34.6	35.2	37.5	35.1	38.3	38.0	37.2
(2)	1.12	11.0	18.9	24.1	27.3	29.4	33.7	32.8	37.2
(3)	8.33	20.1	23.6	25.2	27.4	28.5	28.6	28.9	29.7
(4)	3.55	13.4	22.4	23.3	23.9	25.4	27.9	29.0	30.9
(5)	7.63	18.5	25.9	26.6	26.9	26.9	27.8	28.5	31.0
(6)	2.13	5.93	11.4	14.7	24.5	27.7	28.1	32.2	34.2
(7)	4.26	11.8	18.9	25.5	26.1	25.8	26.8	25.6	28.7

TABLE III

Compressive Strength in Kg. per Sq. Cm.

	6 hrs.	12 hrs.	18 hrs.	1 d.	2 d.	3 d.	5 d.	7 d.	28 d.
(1)	39	277	361	406	487	532	564	570	650
(2)	14	95	162	227	350	414	484	505	546
(3)	62.5	139	185	262	348	400	442	472	546
(4)	32	88	115	160	238	299	374	412	522
(5)	55	112	167	210	321	365	443	492	562
(6)	16.5	39.5	82	147	300	389	453	541	622
(7)	31.5	95	154	219	339	400	414	484	538

Conclusions: (1) 80 to 90% of tensile strength is developed in 18 to 24 hrs. in most cements; (2) increase in compressive strength is much slower; (3) most Japanese Portland cements have pretty high early compressive strength while, with respect to tensile strength, they are far inferior to the super cements; (4) 2-day test is more rational than 3-day test. S.K.

PATENTS

Process of producing calcium aluminate cement. EMILE MARCEL ROCHE. U. S. 1,689,891, Oct. 30, 1928. A process for the manufacture of an aluminous cement, comprising burning a mixture of bauxite and a calcareous material at a temperature of about 900 to 1000°C during a long period.

Manufacture of wood-concrete. PAUL ANFT. Ger. 390,433; *Baumarkt*, **27**, 549 (1928); *Rock Prod.*, **31** [21], 106 (1928).—Sawdust and wood shavings are treated with potassium nitrate and milk of lime, and part with potassium carbonate. The shavings, having been soaked for a certain period, are first dried before they can be worked into seamless floors or into plates, after being moistened with Portland cement mixed in the proportion of 1:5 with water. F.P.H.

Manufacture of wood-concrete. J. F. ROHR. Ger. 456,798; *Baumarkt*, **27**, 549 (1928); *Rock Prod.*, **31** [21], 106 (1928).—Artificial hardwood is made of vegetable fibers, trass, etc., with cement as binder, reinforced with impregnated textile fibers. The mass is compressed into forms under high pressure and made into plates. It is supposed to harden to a degree where the plates can be cut only with metal saws. Plates manufactured thus were placed for 5 days in cold water and then in water heated to 392°F. In manufacturing them, about 14 plates of impregnated sawdust, 10 parts of Portland cement, and 8 parts of trass, asbestos flour, or talcum (by volume) are mixed in dry condition. The mixture is moistened with a ferric salt solution of 3% calcium chloride and 10% ferric chloride and then pressed; the calcium chloride increases the binding ability of the sawdust with the cement, and the ferric chloride increases the strength of the mass and gives it a color simulating oak wood. Then a net of textile fibers having been boiled in a concentrated solution of ferric chloride, alum or calcium chloride is laid in mortar to cover the plates. The complete plates may then be placed in mortar or asphalt upon concrete or wood floors. F.P.H.

Enamels

Shrinkage of cast steel. F. KORBER AND G. SCHITZKOUSKI. *Foundry Trade Jour.*, **39** [622], 47–48 (1928).—The process of shrinkage in large and wide-spreading castings, from the beginning of solidification until room temperature is reached, is discussed. K. and S. experimented with both acid and basic open-hearth steels. Several interesting curves (shrinkage plotted *vs.* time) are given. L.A.P.

Wet process vitreous porcelain enameling. W. MARSHALL. *Foundry Trade Jour.*, **39** [624], 72 (1928).—Common ground coat faults and various means of eliminating them are discussed. L.A.P.

Modernization in the enamel industry. ANON. *Ceram. Ind.*, **11** [5], 469–78 (1928).—An improved air brush has been developed by the Paasche Airbrush Co., which effects an evenly matched spray throughout its entire width, speedier operation, and economical performance. It is convertible to 5 different types of heads, which produce a spray from a fine line up to a gradually widening smooth spray 24 in. wide. The sandblast department in the enameling industry is undergoing several interesting changes which are making this department more efficient in its operations. One sandblast development at the Michigan Enameling Works at Kalamazoo, eliminated sand loss and sand dust in the room. The Chicago Vitreous Enamel Product Co., Cicero, Ill., is finishing its enameled parts in wood graining by both a hand and machine method. Enameling equipment has been greatly developed. In a large plant which operates a continuous enameling furnace, a metal muffle has been installed in the firing zones of the two firing chambers of the kiln, using manufactured city gas as fuel. The new muffle is made of a high heat-resisting alloy, and is formed of plates which, when fitted together, make it impossible for any products of combustion to enter the chamber where the ware is being fired. Its advantages have already been proved. A development which has revolutionized many processes in the enameling industry, is the advancement of acid-resisting enamels. Experience has shown that a cobalt base gives best results because of the good adhesion afforded thereby. The chief duty of the base enamel is that it sticks and does not dissolve the ferric oxidulated outside layer on top of the iron. To obtain an enamel of high chemical resistance, a high content of silicic acid or alumina is necessary. The unusually high percentage of alkali borate must be reduced in favor of the silicic acid so as to obtain greater resemblance to glass. Some enamel experts state that no enamel is proof against all chemical influences, as there are certain limits to the ingredients which can be used, and it will hardly be possible to bring enamel to the same degree of resistance as glass. F.P.H.

Gray cast iron and its influence on tenacity. PETER BARDENHEUER AND KARL LUDWIG ZEVEN. *Stahl u. Eisen*, **48** [16], 515–19 (1928).—The following subjects are investigated: (1) effect of temperature of overheating and chemical composition on the solution of graphite in gray cast iron, (2) influence of the form of graphite on mechanical properties of cast iron, and (3) effect of the pouring temperature on the formation of graphite and the tenacity of cast iron. F.P.H.

Rate of solution of graphite in molten iron carbon alloys. F. SAUERWALD AND A. KORENY. *Stahl u. Eisen*, **48** [17], 537–40 (1928).—A laboratory method for determining the rate of solution of graphite in iron carbon alloys at 1255 and 1350°C is described. The amount of graphite dissolved increases with increasing temperature and also with increasing time. The results obtained by experiments were calculated fairly accurately by assuming that the rate of solution is proportional to the surface and the degree of saturation of the melt. The results are compared with those obtained by Bardenheuer and Hanemann. F.P.H.

Behavior of basic Siemens-Martin ingot steel plates. ERNST POHL. *Stahl u. Eisen*, **48** [20], 649–56 (1928).—The mechanical properties (limit of elasticity, breaking strength, elongation, reduction in area, and impact strength) of a basic Siemens-Martin ingot plate with a tensile strength of 46.8 kg./sq. mm. were determined between 20 and 500°C. The effect of stretching between the same temperatures on the mechanical characteristics at corresponding temperatures was investigated. It is suggested that boilers be constructed in such a manner that the temperature range of the plates will be from 350 to 400°C, rather than from 200 to 300°C. F.P.H.

Crystal orientation and explanation of slip phenomena in stretched, compressed, or rolled metals. G. TAMMANN AND A. HEINZEL. *Stahl u. Eisen*, **48** [21], 693–94 (1928).—The orientation of crystallites in metals can be determined by means of X-rays. A

crystallographic explanation of slip phenomena in stretched or compressed metals is given. F.P.H.

Coating by molten-metal spraying. ANON. *Machinery*, **31**, 505–10 (1928).—The "metalayer" process is described, and some of its many uses are illustrated. The metal to be deposited is fed into a "pistol" as wire; it is melted by a small oxy-acetylene flame, and is then blown on to the object to be coated by compressed air. The coating cannot be separated from the object by severe hammering or bending, and oxidation is prevented by using a reducing flame in the pistol. (*J.I.S.I.*)

BOOK

Bibliography of Metallic Corrosion. W. H. VERNON. xii + 324 pp. Edward Arnold & Co., London, 1928. Price, one guinea. H.H.S.

Glass

Modernization in the glass industry. ANON. *Ceram. Ind.*, **11** [5], 454–69 (1928).—Elimination of dog houses and bridge-walls in glass tanks has been a notable advancement, and the almost universal acceptance of the continuous batch feeder has assisted greatly. Another development is the design of the flat arch continuous tank. The increased use of super refractories, *e.g.*, durox, mullite, and fused mullite for flux block, has also added to the increased efficiency in the melting of glass. Many developments have been made in machines and feeders. One of the latest is the employment of an air actuated feeder, which has been in operation on a commercial tank for some time and proved successful during its test period. The type of leers for annealing has also undergone great change. The newly developed leers are electrically fired, portable, built in sections, and can be used as fireless leers. The annealing time is reduced because of the development of leer design, and the practice of moving the leer right up to the machine has assisted in better annealing glassware. At one of the plants of the Pittsburgh Plate Glass Co., the polariscope is being used to examine the glass as it emerges from the cold end of the leer to determine whether any strains are evident. The polariscope is constructed in such a manner that light underneath the entire width of the sheet is reflected from a polished flat glass surface to the sheet, and then reflected by a mirror placed above the sheet at such an angle that it can be used through a telescope containing a Nicol prism. This examination shows deviations in temperature which can thus be immediately corrected. A new material, uranyl carbonate of sodium, which takes place of sodium carbonate, is one of the interesting developments in raw material. The material costs about one-half as much as sodium uranate, is yellow, turning orange when heated. Uranyl carbonate of soda contains 45% U_3O_8, and gives greater brilliancy to the glass because it dissolves more easily than the carbonic acid escaping during smelting and effects better diffusion. Uranyl, as well as uranate, produces a fluorescent coloring. Reflected, this color is greenish yellow, but emerald green when held against the light. In batches containing lead, both uranyl and uranate produce orange glass. In opalescent and opaque glass the color produced by uranyl carbonate is yellow. Boric acid added gives a lemon-yellow color. By adding oxide of zinc, various orange-reds and even crimson can be obtained. F.P.H.

Electrochemical behavior of silicate glasses. III. M. J. MULLIGAN, J. B. FERGUSON, AND J. W. REBBECK. *Jour. Phys. Chem.*, **32** [5], 779–84; [6], 843–51 (1928).—New evidence has been found concerning formation and disappearance of cathode gas during electrolysis of various glasses and the permeability of glass to various ions. Anode gas was formed at temperatures much lower than those previously reported. Solid electrolytic deposits may be formed in glass near the surface. Those observed consisted mainly of Si and Ag, depending on materials used in experiments. An im-

portant factor in deposit formation is the puncturing of anode glass layers. This is most apt to occur when rapidly moving ions like Ag or Na reach anode layers. Dielectric strength of layers is not only an intrinsic property of the layers but depends also upon nature of ions reaching them. L.A.P.

Traction of glass polishing. F. W. PRESTON. *Jour. Soc. Glass Tech.*, **12** [45], 2–7 (1928).—P. shows graphically the differences in variation in polishing between felt and pitch polishers and felt polishers covered with pitch. The friction between the polisher and the glass depends entirely on the "contact" and the apparent coefficient of friction varies widely with the state of the contact. With pitch, the apparent coefficient of friction may vary from 0.2 or less to a virtual infinity while with felt it usually lies between 0.6 and 1.2. With pitch-covered felts the variation in contact is less than with pitch alone but much greater than with plain felts. D.J.McS.

Analysis of opal and alabaster glasses. J. D. CAUWOOD, J. H. DAVIDSON, AND V. DIMBLEBY. *Jour. Soc. Glass Tech.*, **12** [45], 7–18 (1928).—Owing to the wide variation in opacifying agents used, the analysis of different types of opal glasses should be considered separately. For fluorine glasses free from phosphates, the method of Berzelius and Rose is recommended. The fluoride is precipitated as calcium fluoride in the presence of alkali carbonate and the calcium precipitated as carbonate removed by digesting the gently ignited precipitate with dilute acetic acid. Errors in fluoride determination result from retention of some fluoride by the silica precipitate, solution of some calcium fluoride in the acetic acid, and loss of calcium fluoride through volatilization. Phosphate opal glasses free from fluoride usually contain from 2 to 5% phosphoric acid and are treated in the usual way by fusion with sodium carbonate and the silica separated by nitric acid. The phosphoric acid may then be determined directly by using ammonium molybdate or removed by the use of solid silver carbonate or lead carbonate and acetate and the bases determined in the filtrate. On samples brought into solution by using nitric and hydrofluoric acids, the phosphoric acid is precipitated as phosphomolybdate, dissolved in ammonia and reprecipitated as magnesium ammonium phosphate. Glasses containing both phosphate and fluoride are treated as those containing fluoride alone for the removal of the silica; the phosphate is precipitated with carbonate by using solid silver carbonate and the fluoride determined in the filtrate as calcium fluoride. The colorimetric method for small amounts of fluorine using titanium chloride is suggested for alabaster glasses. Dense opals containing tin oxide are fused with sodium carbonate, evaporated with nitric acid, and the tin oxide and silica brought back into solution by fusing with sodium carbonate and acidifying with hydrochloric acid. The tin is then determined volumetrically or is precipitated with ammonium nitrate and weighed as oxide. D.J.McS.

Analysis of opal glasses. W. SINGLETON AND R. C. CHIRNSIDE. *Jour. Soc. Glass Tech.*, **12** [45], 18–27 (1928).—Methods are given for the determination of constituents of complex glasses. Lead is determined in the filtrate from the silica by precipitation with hydrogen sulphide, solution of the lead sulphide in dilute hydrochloride acid and bromine, and conversion to sulphate by evaporation with dilute sulphuric acid. Lead can be determined on a separate sample after removal of the fluorine by evaporation with sulphuric and hydrofluoric acids, solution of the lead sulphate in ammonium acetate, and titration with ammonium molybdate using tannic acid as indicator. Lime is precipitated in the usual way, weighed as sulphate, or determined volumetrically using permanganate. Zinc is separated as sulphide, redissolved and precipitated as carbonate, ignited and weighed as oxide. The volumetric method of Cone and Cady for determination of zinc using potassium ferrocyanide with diphenylamine or diphenylbenzidine as indicator gave good results. Boric acid should be removed by evaporation with sulphuric acid and alcohol before separating iron and alumina, and is determined

in the usual way by the method of E. T. Wherry. The presence of up to 5% of fluorine does not interfere with the boric acid determination. Zirconia is weighed as pyrophosphate by Hillebrand's method. Arsenic is separated as sulphide, redissolved in sulphuric acid, and titrated with iodine. D.J.McS.

Ultra-violet light transmission of colorless bottle glass. D. Starkie and W. E. S. Turner. *Jour. Soc. Glass Tech.*, **12** [45], 27–31 (1928).—Estimation of the absorption spectra of commercial decolorized glasses used as food containers showed a definite relation between the absorption of the ultra-violet and the iron content of the glass. Soda-lime-silica glasses with as low an iron content as 0.005% transmit radiation as short as 2600 Å while the limit of transmission of commercial glasses of 0.07% iron content is about 3000 Å. The presence of titania in the glass also affects the transmission of the ultra-violet. D.J.McS.

Influence of iron oxide on properties of glass. S. English, H. W. Howes, W. E. S. Turner, and F. Winks. *Jour. Soc. Glass Tech.*, **12** [45], 31–52 (1928).—Small pot melts of the general formula $6SiO_2(2-X)Na_2O \times Fe_2O_3$ showed easy melting and refining at 1400°C when containing up to 222 lbs. of Fe_2O_3 per 1000 of sand and somewhat more difficult and slower melting and refining up to 444 lbs. iron oxide per 1000 of sand. Glasses containing more than 250 lbs. of iron oxide showed a heavy boil in the latter stages of the melting possibly from partial dissociation of ferric to ferrous oxide. All glasses except those of the highest iron content were satisfactory to work. The glasses of lower iron content were very soft. All glasses showed the rapid chilling and the ease of reheating characteristic of highly colored glasses. These iron glasses showed but little corrosive action on the sillimanite pot used. All the iron was added to the batch in the ferric form. The ferrous oxide content of the glasses varied from 9 to 22% of the total iron as ferric oxide and in the majority of the glasses was about 15% of the total iron. The color of the glasses varied from bright yellowish green to black by transmitted light and all except that containing the least iron oxide were black by reflected light in thicknesses of about 1 cm. Results indicated that the addition of iron oxide increased the hardness of the glass appreciably. Using the formula of Winklemann and Schott in determining the density constants of ferrous and ferric oxides, the authors arrive at 3.0 as the constant for ferrous oxide and 4.8 as the constant for ferric oxide. A substitution of ferric oxide for soda raises the annealing temperature but not as much as lime does. The effect on the annealing temperature is not regular, probably owing to variation in the amount of ferrous oxide present. Iron oxide is less effective in raising the annealing temperature than lime, magnesia, alumina, or moderate amounts of boric oxide. Replacement of soda by iron oxide causes a decrease in the coefficient of expansion of the glass. D.J.McS.

Relationship between chemical composition and resistance of glass to action of chemical reagents. II. Glasses containing iron oxides. V. Dimbleby and W. E. S. Turner. *Jour. Soc. Glass Tech.*, **12** [45], 52–57 (1928).—The glasses treated in Part I were submitted to the action of boiling water, hydrochloric acid, double normal sodium carbonate, and double normal sodium hydroxide. Ferrous and ferric oxides do not appear to differ appreciably in their effect on the resistance of glass to chemical action. The resistance of the iron-containing glasses throughout this series to the action of boiling water is greater than that of similar series containing lime, baryta, and lead. It is greater than that of magnesia up to 12 molecules, then similar; than zinc oxide up to 10 molecules; than alumina glasses up to 8 molecules; or zirconia glasses up to 4 molecules and then similar. Their resistance to boiling water is greater than that of titania glasses up to 8 molecules and then less resistant. The resistance of the iron glasses to the action of boiling hydrochloric acid is greater than that of similar glasses containing lime, magnesia, or zinc up to 6 molecules, alumina, zirconia, or titania up

to 4 molecules, and baryta or lead up to 8 molecules and are then less resistant in all cases. Their resistance to boiling sodium carbonate solution is greater throughout the series than glasses containing lime, baryta, lead, or magnesia; is greater than that of glasses containing zinc or alumina up to 4 molecules and is less resistant than the zirconia glasses throughout the series. The action of boiling sodium hydroxide solution is greater on iron glasses throughout the series than on similar zirconia glasses, but is less than on glasses containing lime, alumina, and magnesia up to 4 molecules, baryta and zinc up to 6 molecules, lead up to 8 molecules, and titania up to 12 molecules. For Part I see *Ceram. Abs.*, **6** [3], 98 (1927). D.J.McS.

Casing of colorless by cobalt blue glass. I. Thermal expansions. W. E. S. TURNER AND F. WINKS. *Jour. Soc Glass Tech.*, **12** [45], 57–82 (1928).—The addition to colorless soda lime glasses of cobalt oxide up to 0.5% has an effect on the coefficient of expansion of not more than 3%, except in the annealing range, and the effect of such addition on the upper and lower annealing temperatures is only about 5°C. The maximum effect of the addition to potash lead glasses of up to 0.9% cobalt oxide is about 3% up to the lower annealing temperature. The lower annealing temperature of potash lead glasses is raised progressively by increasing amounts of cobalt oxide, the increase in temperature being as much as 25° in the case of the addition of 0.9% cobalt oxide. Whether or not two glasses can be united successfully depends, insofar as thermal expansion is concerned, on the difference of thermal expansion between the glasses at any one temperature and whether or not change points occur in the thermal expansion in the temperature range below the lower annealing temperature and the relation between such change points in the two glasses. **II. Setting rate.** The difference in the commercial working of colorless and colored glasses (which differ in composition only in the amounts of coloring oxides present) cannot be ascribed to differences in viscosity resulting from the presence of such coloring oxides, because the effect of the latter on the viscosity of the glass is insufficient to produce the observed results, and, in fact, is often of the opposite order from that which would give the observed results. On this account, viscosity determinations of glasses in closed vessels cannot be taken as a criterion of the action of colored glasses in commercial working operations. The rate of rise in temperature, and consequently the rate of viscosity increase, in the outer layers is shown to be greater in the case of colored than with colorless glasses, due to the greater radiating power of the former. D.J.McS.

Calculation of glass constants. E. ZSCHIMMER. *Jour. Soc. Glass Tech.*, **12** [45], 82–118 (1928).—A review of the literature on the determination of glass constants published from 1923 to 1927. Z. suggests that, in order that critical tables of glass constants may be more easily available to the glasshouse engineer as a means of calculation of industrial glasses, (1) complete compositions be stated in percentage by weight of the oxides; (2) all glasses be arranged in the form of connected series; (3) particular constants which correspond with an addition of the various oxides in steps of 2% be evaluated from the existing measurements; and (4) dependence of the value of the constants on the percentage weight of the glass oxide be set in tables. D.J.McS.

Mirror production. ARTHUR LAURENT. *Diamant*, **50** [14], 292–94; [16], 332–35; [19], 392–93 (1928).—The finishing processes, various inspections and classifications of the product, packing, storage, and shipping of the mirrors are taken up in some detail. The material included in this series of articles is to be published in book form. See also *Ceram. Abs.*, **7** [1], 17; [7], 435 (1928). E.J.V.

Mechanization of the small glassware industry. ERNST STOCKAUER. *Diamant*, **50** [15], 313–14 (1928).—A discussion pointing out the rapid strides made in America in mechanization of the various branches of the glass industry, and considering what

will be done by Germans to compete with it if the movement enters the field of small glass articles which are now being made by hand. E.J.V.

Alumina and feldspar as sources of alumina in glass. R. K. McBERTY. *Glass Ind.*, 9 [10], 215–16 (1928).—During the past fifteen years, after a great amount of research, the realization of the value of Al_2O_3 in glass has grown rapidly. Due to the many advantages afforded, such as increased strength, greater brilliancy, longer working range and better working properties, many producers are incorporating from 1% up to 3 or 4% of Al_2O_3 in their glass batches in the form of aluminum hydrate, aluminum oxide, or feldspar. It is not known which is the best source of aluminum oxide for glass. Three main factors, however, must be the deciding elements: (*a*) solubility in the melt; (*b*) constancy of composition; (*c*) relative purity. It is generally conceded that alumina, hydrated or calcined, is a more satisfactory material from the standpoints of purity and constancy of composition. The manufacture of these materials is carried on by a process which precludes the presence of more than a trace of iron oxide (0.007% is the average Fe_2O_3 content). Combined moisture is practically constant in either the hydrated or the calcined product. Feldspar, on the other hand, is a mineral of igneous origin, and consequently shares the variations in composition common to all mined and quarried products. The amount of feldspar used in a batch will be nearly five times the percentage of alumina desired. Thus, small variations in the composition are really important. Since 0.2% Fe_2O_3 is the upper limit for a high grade glass, a feldspar must be carefully watched, to avoid contamination of the ingredients. No data being available as to the relative solubilities of these two materials, experimental work, on two types of glass which were selected as the most likely to give generally applicable results, was undertaken to determine their respective merits. Of the two types of glasses, soda lime silicates and sodium borosilicates, the former is of greater economic importance. Methods and batches used in making experimental determinations are discussed. The data obtained indicate that in glassmaking (1) hydrate of alumina has an equal or greater solubility than felsdpar when the soda content of the glass is derived from soda ash; (2) feldspar has an advantage in solubility over hydrate of alumina where all soda contents are derived from salt cake; (3) where the soda contents are derived from both soda ash and salt cake, the advantage of one over the other is proportionate to the mixture; (4) both hydrate of alumina and feldspar are more soluble than aluminum oxide; (5) hydrate of alumina has the advantage over feldspar as to uniformity of composition; (6) hydrate of alumina on account of its purity has advantage over feldspar in the color of the finished glass. E.J.V.

Feldspar and alumina as sources of alumina in glass. V. V. KELSEY. *Glass Ind.*, 9 [10], 217 (1928).—Progressive feldspar producers have greatly improved their product in recent years, and the product of those who have close check on the quality of their output has an iron content below the upper limit allowed for a high grade glass. Feldspar has a composition closely approaching that of some types of glass, the result being that this material quickly unites chemically with the other glassmaking ingredients, and in this respect functions to a considerable extent quite similar to cullet. The alumina, potash, and soda in feldspar have already gone through a melting process in nature to the extent that they are chemically combined with the silica to form a definite silicate. Therefore, the alumina is already in solution. Feldspar goes into solution quickly in the production of glass on a commercial basis in either pot or tank furnaces; none is lost or remains undissolved. Glass having a desired chemical composition, calculated to contain a certain predetermined percentage of alumina, is easily obtained with the use of feldspar. A number of glass manufacturers have found that by adding a certain percentage of aluminum hydrate or aluminum oxide to the glass batch, and

later making a careful chemical analysis of their finished glass, they do not find as much alumina as they should, thus proving that a certain percentage of the hydrate or oxide still remains undissolved in the tank. Feldspar is easily handled and readily mixed with the other glassmaking ingredients. E.J.V.

Health hazards of the glass industry. II. M. M. MCMAHON. *Glass Ind.*, **9** [10], 221–26 (1928).—Methods used in decorating glass are described in detail. The principal hazards are: (1) lead poisoning from the large amount of paints handled; (2) hydrofluoric acid fumes and burns; (3) turpentine poisoning. The processes of making stained and leaded glass windows have as attendant hazards: (1) lead poisoning; (2) carbon monoxide poisoning; (3) inhalation of glass dust; (4) cuts, scratches, and burns and subsequent infections. In bent glass factories the principal hazards are: (1) lead poisoning from dross disengaged from lead pots and from the use of solder, which if not removed by exhaust systems is scattered as dust in the air of the workroom; (2) dust from metal polishing and buffing wheels; (3) acid burns and fumes, and carbon monoxide from gas used for soldering stoves and bending forges; (4) heat and glare from the torches and bending furnaces; (5) exposure to poisoning from lead in paint, wood alcohol, amyl acetate, and turpentine used in varnish and shellac. Recommendations for safeguarding workers against these hazards are made. (For Part I see *Ceram. Abs.*, **7** [11], 749 (1928).) E.J.V.

Nature of glass. ROY E. SWAIN. *Glass Ind.*, **9** [10], 233 (1928).—Viscosity variability probably gives the glass worker greater cause for thought than any of the other variable qualities of molten glass. Some glasses appearing to be quite cold and stiff when gathered may be worked slowly with little show of increasing viscosity. These glasses are known as slow setting glasses and are usually considered best for machine work as they reheat more consistently and are said to "hold the heat well." While they may not be able to retain the heat any better than many other glasses they remain fluid longer. The other extreme is found in some of the low expansion glasses usually known as heat resisting glasses. These are worked at an extremely high temperature and rapidly enough to finish the article before the glass sets. These are known as quick setting glasses and from a standpoint of quantity production are considered desirable for hand work. Some glasses remain workable for a greater period of time after being removed from the furnace than others. These may possess a greater specific heat, a lower conductivity of heat, the ability to remain fluid through a greater range of temperature, or a combination of these properties. They are classed by the workmen as slow setting glasses. Other glass remains workable for only a short time because of lower specific heat, greater conductivity of heat, or inability to remain fluid over a very great range of temperature. The glassworkers call these glasses quick setting glasses. Some glasses, usually rich in alkali or having a complex composition, which melt quickly at low furnace temperatures and are readily worked at low temperatures, are known as soft glasses. Those difficult to melt at extremely high furnace temperatures and which require special care and training in working are usually rich in silica or acid content and are known as hard glasses. Between these extremes are countless glasses of various degrees of hardness. These are known as hard or soft glasses according to the uses to be made of them or the melting equipment available for melting them. What may be considered a hard glass in a tableware factory would be classed as a soft glass in a plant manufacturing technical and scientific glassware. Some glasses lack consistency and are usually classed as "lumpy" by the workmen. Such glasses usually work as though a soft and a hard glass had been melted together without stirring. Thus we have what appears to be lumps of a sluggish glass held suspended in a more fluid glass. It is difficult to secure symmetrically shaped gathers of uniform weight from such glass and even more difficult to secure even distribution in the blown ware. Such glasses which may often be worked

as pressing glasses may be a constant source of trouble and dissatisfaction as blowing glasses. E.J.V.

Corning Glass Works' sixtieth anniversary. ANON. *Glass Ind.*, 9 [10], 236 (1928).—The anniversary of the Corning Glass Works was celebrated with a dinner at which all the employees who had given the company fifteen or more years of continuous service were guests. This group included over 300 employees. Service buttons were awarded to all those present at the dinner and also to all having served at least ten years, which brought the total number up to 770. E.J.V.

Insulation in the glass plant. J. D. VANVALKENBURGH. *Glass Ind.*, 9 [10], 241–48 (1928).—Advances made in the technique, etc., of glass manufacture include economies and advantages in furnace operations resulting from suitable insulation. Answers to questions of where insulation should be applied and how to know the proper thickness may be stated in a series of rules: (1) suitable insulation should be applied to every surface where the net result of this application is beneficial or advantageous; (2) where furnace temperatures are high, insulation must not be so thick as to raise the mean temperatures of the refractories beyond the limit of safety; (3) insulation should not be great enough that it would be appreciably disintegrated by the temperatures impressed upon its inner surface; (4) subject to the above limitations, insulation should be used in such thickness that the benefits accruing from it will pay the required return on the investment occasioned by the installation. Other effects of insulation are enumerated. The insulation of gas producers, producer mains, tank and pot furnaces, recuperators, regenerators and uptakes, annealing furnaces and leers, preheating arches, glory holes, flattening furnaces, etc., is taken up in considerable detail with examples of the calculations involved. The importance of suitable furnace insulation properly applied should receive the attention of all glass manufacturers. E.J.V.

Chemistry of glass. W. C. TAYLOR. *Glass Ind.*, 9 [10], 248–50 (1928).—This paper, presented at the September meeting of the Glass Container Assn. at Montreal, Canada, by the chief chemist of the Corning Glass Works, discusses the principal kinds of glass in general use and briefly points out the lines along which progress in glass chemistry probably will be made in the future. The chemistry of glass being a relatively new branch of science, there are still many reactions not yet satisfactorily explained. Much more research work is needed. Now that commercial glasses free from alkali and silica have been produced new terms are needed with which to define glass. Lime, lead, borosilicate, and colored glass are discussed. E.J.V.

The glass furnace as a heat engine. D. AUFHÄUSER. *Glastech. Ber.*, 6 [7], 372–79 1928.—Heat is a form of energy, therefore every production of heat means the production of energy, in a glass furnace as well as in a motor. A glass-melting furnace can therefore be properly described as a "heat engine." The differences lie only in the time element, which depends on the mechanical and thermal resistance. From this point of view speed of heat transfer is recognized as the most important feature of a glass-melting furnace. This speed depends always on two factors: the temperature drop or difference between inlet and outlet and the effective or direct heat absorbing surface. Since the temperature drop is small, due to the high working temperature of the glass, the importance of the size of the effective heating surface becomes very considerable, especially in comparisons between tank and pot furnaces. Heat transmission takes place by convection (gas currents) and radiation. Transmission by conduction is secondary. The effect of heat radiation is of outstanding importance, because it takes place at the speed of light from all surfaces in every direction. It must therefore be considered as the most direct effect of the combustion process. Radiation of heat may be controlled and employed usefully by the use of reflection; the size

and shape of the glass-melting furnace are therefore important. In all furnaces the rate of heat loss is very considerable. Hence the heat current is directed into a second stage of thermal resistance, the regenerator chambers, from which the energy can be recovered for further use. E.J.V.

Discussion on the Peddle generalization. KOZO TABATA, SHIZUTA MORIYASU, AND KENSUKE YEGAMI. *Jour. Soc. Chem. Ind., Japan*, **31** [10], 239–40B (1928).—Three terms of conclusions were given by C. J. Peddle in his paper (*Jour. Soc. Glass Tech.*, **5**, 195–201 (1921); *Ceram. Abs.*, **1** [12], 329 (1922)). The first term is not true for glasses containing 10% alkali. The second term is discussed as follows: Assume that $K_2O = p$, $Na_2O = q$, $SiO_2 = m$, $PbO = n$, and $p + q = c$, m and n are constants and the glass formula is expressed by $\left.\begin{matrix} xK_2O \\ (1-x)Na_2O \end{matrix}\right\}$ zPbO, $y$$SiO_2$, and the solubility by s: then $s = f(x,y,z)$ and $\frac{ds}{dp} = \left(\frac{\delta s}{\delta x}\right)\left(\frac{\delta x}{\delta p}\right) + \left(\frac{\delta s}{\delta y}\right)\left(\frac{\delta y}{\delta p}\right) + \left(\frac{\delta s}{\delta z}\right)\left(\frac{\delta z}{\delta p}\right)$.

For a certain condition, $\frac{ds}{dp} = 0$ or the solubility may be minimum. To condition the minimum solubility, it is necessary to get the values of $\delta s/\delta x$, $\delta s/\delta y$, and $\delta s/\delta z$ more accurately. And for this purpose the surface area, the surface condition, the temperature, etc., should be determined more correctly. The third term has many defects: first, the change of density of glass by substitution of PbO for SiO_2 in equal weights was not considered. The change of density may exceed 10% for the two series of glasses in comparison. Besides this error, the term is not applicable for more soluble glasses. It is explained as follows. The term may be expressed when p,q and $m + n$ are constant and $n < 50$, then $(\delta s/\delta n)$ p,q should be negative. This condition may be expressed

$$\left(\frac{\delta s}{\delta y}\right)\left(\frac{\delta y}{\delta n}\right) + \left(\frac{\delta s}{\delta z}\right)\left(\frac{\delta z}{\delta n}\right) < 0 \quad \text{or} \quad 3.716\left|\left(\frac{\delta s}{\delta y}\right)\right| < \left|\left(\frac{\delta s}{\delta z}\right)\right|.$$

Since the results of the experiments on $1.0K_2O$, zPbO, $y$$SiO_2$ glasses (z = 0.25, 0.5, and 0.75; y = 3.5, 4.0, and 4.5) show very definitely the relation to be

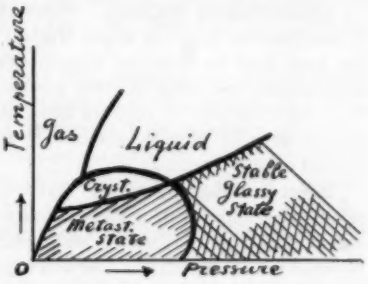
$$3.716\left|\left(\frac{\delta s}{\delta y}\right)\right| > \left|\left(\frac{\delta s}{\delta z}\right)\right|$$

it is clear enough that the results of the experiment prove facts just contrary to Peddle's third terms. E.J.V.

State assistance for glass works in Chile. ANON. *Pottery Gaz.*, **53** [617], 1745 (1928).—The Chilean Government has submitted to Congress a bill for the erection in Chile of a modern plate glass factory, having an annual minimum output of 35 million kg. For the first 5 years the state will grant the factory premiums on its production, while for the first 10 years the state will also grant a premium of 15 centavos on each kg. of glass exported, but not more than $70,000 will be paid in one year. As soon as the factory has been opened the duty upon plate glass of under 4-mm. thickness will be increased. All plant and machinery required will be allowed to enter the country free of duty, and, for the first year, the concern will be freed from all rates and taxes. E.J.V.

Glassy state of matter. P. P. LASAREFF. *Ceramics and Glass*, No. 6, 136–38 (1928).—It was shown by a number of experiments (mostly by Tammann) that the solid state of matter is crystalline. It is known, however, that matter can assume also an amorphous state, the examples of which are ordinary glass and amorphous selenium. The relation between the solid and glassy states is discussed. When matter

is cooled carefully it can reach such a state that the individual molecules possessing all properties of liquid and having different volumes and energy are at such distances between each other that their mobility becomes zero. In this case molecules can move with a great friction only and matter is then in an amorphous state which may be regarded as a certain modification of the liquid state. Thus, the characteristics of this glassy state are small mobility and the presence of the molecules possessing a great internal energy. The same matter at the same temperature can assume a state where the intermolecular forces are immense but cooling is not carried on carefully enough. The large molecules, which can be preserved by very careful cooling only, are then destroyed and there is the case where all molecules have the same volume corresponding to the minimum energy and are of same dimensions. We have then a stable equilibrium where atoms and molecules are arranged in the space lattice and form crystals. The glassy state in which molecules do not possess minimum energy corresponding to a given temperature is an unstable state. Molecules here tend to assume the stable state by losing their energy. This loss of energy which is correlated with the internal intermolecular radiations should produce a certain positive heat effect observed during the transformation from amorphous to crystalline state. It should be pointed out that the whole discussion is based on the kinetic theory of gases and the quantum theory. Relative molecular energies of crystalline and amorphous matter may be seen when matter is dissolved in water. An amorphous body should liberate a greater amount of energy (Q_A) as compared with the energy liberated by the crystalline one (Q_K) of the same composition. The following table may illustrate this point:



	$LiBO_2$	$Mg(BO_2)_2$	$Ca(BO_2)_2$	$Sr(BO_2)_2$
$Q_A - Q_K$	56	120	50	31

The distances between atoms in the crystalline state are of the order 10^{-8} cm., the atoms and molecules assuming the minimum volume which corresponds to the orbits of the electrons of the first order. Accordingly, the density of the matter in its crystalline state would have the maximum value while the same matter in amorphous state would possess a smaller density, as may be seen from the table below:

		Densities
Arsenic	Crystalline	5.727
	Amorphous	4.710
Boron	Black monoclynic crystals	2.535
	Yellow cubic crystals	2.615
	Amorphous	2.450
Sulphur	Rhombic crystals	2.070
	Monoclynic crystals	1.958
	Amorphous	1.920
Selenium	Metallic crystalline gray	4.800
	Amorphous red	4.260
Antimony trisulphide	Crystalline	4.750
	Amorphous	4.150

The hardness of matter depends on the number of atoms and increases with their number, therefore it should increase in the direction amorphous ⟶ solid state of matter. Thus, in the amorphous state we have a special metastable condition characterized by a series of new properties which are absent in the liquid as well as in the solid

crystalline states. The diagram given by G. A. Tammann shows that the glassy state is stable at high pressures. With the gradual increase of pressure on the space lattice of crystal some new stable states of matter may be obtained where atomic arrangement is similar to that of the liquid phase and there we reach the glassy state. A.I.K.

Chemists in German glass industry. SCHARF. *Chem. and Ind.*, **47**, 1160 (1928).—According to the recently published census of professions in Germany, there are in that country 10,574 university-trained chemists, of whom 921 are women. The number for those employed in the glass industry is 32, of whom 3 are women. No chemist-directors are reported in glass. H.H.S.

PATENTS

Glass-grinding machine. STEPHAN P. MERMER. U. S. 1,687,985, Oct. 16, 1928. A machine for grinding edges of glass plates comprising a line of support upon which the glass may be stood on edge in substantially vertical position, means for guidingly maintaining the plate in such position, grinding means rotated substantially on the level with the line of support and onto which the glass plate moves so that the edge thereof may be ground, and means for turning the glass in order that another edge thereof may be ground.

Sheet-forming apparatus. JOHN L. DRAKE. U. S. 1,688,528, Oct. 23, 1928. In sheet glass apparatus, a glass furnace, containing molten glass, means to discharge a gob of glass from the furnace, and a plurality of pairs of superimposed rotatable members between which the glass is adapted to pass to be reduced to sheet form.

Method of and apparatus for annealing glass. FRANK W. PRESTON. U. S. 1,689,048, Oct. 23, 1928. The method of annealing sheet glass, which comprises passing a plurality of sheets of glass through a leer in tandem relation, preventing flow of air past the space between adjacent edges of the sheets, and subjecting each sheet to different temperature conditions.

Glass-forming machine. THEODORE H. SLOAN. U. S. 1,689,975, Oct. 30, 1928. In a glass-forming machine, the combination with a source of supply adapted to deliver glass, of a frame, a continuously rotating turret provided with a plurality of forming units continuously movable with it, a plurality of glass-receiving cups borne by the turret and movable with the turret each in registration with a forming unit, means borne by the frame for successively engaging and holding each cup stationary at the delivery station to receive glass, and means borne by the turret for subsequently causing each cup to move with the turret in registration with a succeeding forming unit.

Glass-delivery apparatus. MEYER M. EPPSTEIN. U. S. 1,690,777, Nov. 6, 1928. A revolving tank to contain molten glass, including a compartment from which charges are gathered, a compartment surrounding the first named compartment to receive portions of glass severed from charges gathered in the inner compartment, and means for causing a reheating and transferring of the chilled portions from the outer to the inner compartment.

Apparatus for supplying molten glass to molds. LEONARD D. SOUBIER. U. S. 1,690,998, Nov. 6, 1928. The combination of means for supplying a body of molten glass, means to cause movement of the glass past a gathering point in a path by which the glass is again returned to the gathering point, and means for forcing beneath the surface of the glass for reheating reassimilation portions thereof which have been chilled at the gathering point.

Glass manufacture. BRITISH HARTFORD-FAIRMONT SYNDICATE, LTD., AND T. WARDLEY. Brit. 295,762, Oct. 10, 1928. An apparatus for feeding molten glass is provided with a temperature-indicating device, the heat-responsive part of which is situated close to the aperture through which the molten glass is discharged.

Annealing and rolling glass. Soc. anon. des Manufactures des Glaces et Produits Chimiques de St.-Gobain, Chauny, et Cirey. Brit. 296,282, Oct. 24, 1928. Relates to the manufacture of glass plates or sheets by rolling apparatus which is fed intermittently with molten glass. Sheets from a single rolling-machine are fed in turn to two or more leers through which the sheets move at a speed suitable for annealing. The sheets, as they are formed, are received on a carriage, which conveys the sheets transversely to the mouth of the leer. The surface of the carriage is formed as a roller conveyer and the rollers are driven at a speed which can be varied, as described in Brit. 279,860. The rollers as they receive a sheet are driven at a peripheral speed equal to the speed of rolling, but as soon as the sheet is wholly on the table, the speed is reduced so that the sheet is fed into the leer at the slower speed at which it travels through the leer. A hood or muffle covers part of the table in order to prevent the sheet from being chilled unduly before it passes to the leer. Two carriages may be used to receive sheets in turn from the rolling machine.

Rolling glass. Naamlooze Vennootschap Mij Tot Beheer en Exploitatie van Octrooien. Brit. 296,444, Oct. 24, 1928. Relates to a device for cutting a strip of sheet glass while it is still hot and plastic and is resting on the conveyer that carries it from the rolling mechanism to the leer. The device comprises a cylinder which is arranged obliquely across the conveyer and is formed with a helical groove that co-operates with blades secured transversely to, and projecting above the surface of, the conveyer. The cylinder is carried by bearings which are free to move vertically against the action of springs. The engagement of the groove and the blade continues the rotation of the cylinder until the strip of glass has been cut through from one edge to the other. When the table is run back to receive another strip of glass, the levers swing about their pivots as they pass under the flange, the springs returning them to the vertical position as they move clear of the flange.

Heavy Clay Products

Effect of thermal shock on transverse strength of fireclay brick. C. W. Parmelee and A. E. R. Westman. *Jour. Amer. Ceram. Soc.*, **11** [12], 884–95 (1928).—An apparatus is described by means of which a fire brick, initially at a temperature of 1100°C, could be subjected to definitely localized thermal stresses by cooling the center of one face of the brick with an air blast, the remaining surface of the brick being protected by means of heat insulation. By means of this apparatus, the effect of thermal shock on the transverse strength of twenty brands of fireclay brick was determined. The values obtained are compared with the other physical and chemical properties of the brands. The advantages and disadvantages involved in the use of this method as a laboratory test for the determination of resistance to thermal shock are discussed.

Enameled sand-lime brick. Anon. Bur. Stand., *Tech. News Bull.*, No. 138, p. 145 (1928).—The Bureau recently tested the weathering qualities of brick enameled on one edge with a cellulose type of enamel. The results while unfavorable to the particular specimens tested nevertheless may be of general interest. The enamel was applied in an extremely thin coat to the surface of the brick. It was found that the enamel softened and discolored on immersion in hot water or on dry heating at 110°C. The enamel cracked or chipped in less than 30 alternations in the freezing and thawing test. The results indicate that this type of finish is unsatisfactory both as to permanence of color and finish. In the development of any coloring process for sand-lime brick the strongly alkaline nature of the brick must be considered. R.A.H.

Efflorescence on brickwork. W. Angus McIntyre. *Brit. Clayworker*, **37** [438], 252–55 (1928).—Efflorescence, *i.e.*, the crystalline deposits which appear on bricks

and brickwork after exposure to the atmosphere is a problem of great importance to all connected with the building industry. The Building Research Station at Watford has commenced an investigation into certain aspects of the problem. All efflorescence consists of salts which are soluble in water, although the degree of solubility may vary enormously. The fact that the salts ordinarily present in efflorescence, *i.e.*, calcium carbonate and sodium sulphate, are soluble in water indicates that the best way of removing them when they appear is washing in plain water. Spirits of salt (hydrochloric acid) is often recommended for the removal of efflorescence, but this practice cannot be too strongly condemned. The acid not only decomposes the brick but also attacks the mortar, giving rise to more very soluble salts. There are very few efflorescences which will not be entirely removed by washing with plain water. Analyses of nearly 100 efflorescences from widely differing materials in various parts show the dominant constituent to be sodium sulphate. The origin of salts causing efflorescence may be divided into two classes: (1) those which were originally present in the brick when it was laid, and (2) those which have been introduced into the brick since its exposure. The salts originally present in the brick as laid may arise in several ways; salts of sodium, potassium, magnesium, and calcium are present in raw clay and may not be fully decomposed in the kiln. As a rule the sulphates withstand the temperatures ordinarily met with in brick kilns without any appreciable decomposition, and at present it is fairly safe to assume that most sulphates which were originally present in the clay will remain as such in the finished brick. Other sulphates may be introduced with the tempering water; small quantities may be formed as a result of oxidation of pyrite during grinding. Further additions of sulphate may occur in the green brick and in driers where waste gases from the kiln are brought into direct contact with the ware. The only known method of overcoming the effects of the sulphates just mentioned, all of which are present in the brick before it reaches the kiln, is by the addition of a barium salt to the batch. This method, although quite effective in certain cases, is rather expensive and can be used economically only with special ware; in any case it has no action on sulphates which may enter the brick during and after firing. Another source of sulphates in the finished brick is the absorption of sulphur dioxide from the fuel, clay, or kiln gases during firing, particularly while the bricks are moist. The sulphurous acid thus formed acts on the clay to give sulphates. Soluble salts may enter the bricks subsequent to erection in 4 ways: (1) present in the mortar; (2) action of acid gases of the atmosphere and so enter the brick; (3) through capillary action of rain or ground waters; (4) salts present in the atmosphere may be carried directly to the brick. When mortar is suspected as a source of efflorescence, there are two distinct cases to consider, Portland cement mortars and lime mortars. Dolomitic limes which are extensively used might form the readily soluble magnesium sulphate which is often found as a constituent of efflorescence. R.A.H.

Artificial brick. ANON. *Brit. Clayworker*, **37** [438], 266 (1928).—In a German patent for the manufacture of artificial building blocks, marl is substituted for sand in the sandlime brick mixture. The resulting product is looser in structure and lighter than the sandlime brick, but shows no loss of compressive strength. If the material is treated with superheated steam before pressing, a particularly strong and durable brick is obtained and the alkaline constituents are fixed preventing later efflorescence. R.A.H.

Hollow block making. LESLIE R. ALT. *Brit. Clayworker*, **37** [438], 266 (1928).—Probably the most common source of loss to the hollow ware manufacturer is that due to checks which occur in the ware during the drying and firing periods. Very unbalanced dies will show their condition on the moving column by tearing the corners, splitting, or otherwise distorting the column. However, a die sufficiently unbalanced

to cause excessive drier or kiln loss may exhibit no sign of poor regulation. The product of such a die will show no defect until the ware is dry. In order to determine the origin of such a defect test blocks were made on the machine and cut into 4 sections. Each section was carefully marked and then measured for drying shrinkage. The measurements obtained showed distinctly the unbalanced condition of the press. This condition was overcome by using retarders in dies. R.A.H.

Modernization. ANON. *Brick Clay Rec.*, **73** [9], 577–608 (1928).—In the pit and mine, many improvements have been made in both the types of equipment used for clay winning and the methods of operating pits and mines. The modern features in clay storage include the use of overhead cranes, power hoes, conveyer belts, and automatic feeders. In crushing and grinding, very serious consideration has been given secondary crushing. Not only have there been many refinements in the dry pan but this machine has been supplemented and in some instances entirely replaced by other types of grinding machinery. Processes in the department of clay preparation have remained the same, changes and new developments here coming in the design of machinery. The old piano wire screen has been almost entirely replaced by the vibrating screen, which has proved itself an efficient agent for sizing clay particles. Big improvements have been made in auger machine design and construction resulting in improved products and greatly reduced power consumption. Other molding improvements include the Penfield hacking machine, the Poston process of veneering brick, mold washers, repress machines, new model brick machines, pallet loaders, and automatic cutters. New developments in the field of drying include automatic temperature control instruments, new types of drier cars, improved drier roof construction, a metal type drier door with fire-resisting qualities and high insulation value, and a drier car puller. Remarkable changes are being made in firing systems. The tremendous increase in the use of tunnel kilns has forced a more and more intensive study of firing methods and a more extensive application of equipment that will help to improve products and reduce cost. Chief among such equipment is the greatly increased use of fans and blowers and a wider interest in control devices. Kiln cooling fans are used almost universally because they speed up kiln turnover; similarly with fans for increasing draft during water-smoking. Portable scoving, oil burning, stokers, smoke elimination, gas producers, and burners are discussed. In the field of power and power transmission in the clay industry, the increasing popularity of the Diesel or oil engine is of greatest importance. Speed reducers, variable speed transmission, and the application of roller and ball bearings are other modern features. Under a general heading the following items are discussed: handling of materials, green and finished products; shipping; paper covering (Sisalkraft); caterpillar tractor for odd jobs; adaptation of X-rays to ceramics; organic binders; special metals for unusual service in operations where resistance to abrasion is necessary; modern types of agitators; modern buying; and standard building construction. E.J.V.

Firing brick with powdered coal. ANON. *Clay-Worker*, **90** [4], 269–76 (1928).—The Ohio Clay Co., Cleveland, Ohio, is furnishing the greater part of that city's hollow tile and brick. The output of the plants is not confined to Cleveland but shipments are made to outside points. The new plant produces over 60,000 brick daily, fired in a Harrop tunnel kiln using only 200 lbs. of powdered coal per 1000 brick. There are many unusual features of particular interest to clayworkers. The clay is all Cuyahoga blue shale, free from stone and an ideal clay from the standpoint of plasticity and quality. It produces a very strong body. E.J.V.

Factory design and equipment. XIX. T. W. GARVE. *Clay-Worker*, **90** [4], 282 (1928).—A brief discussion of the subject of labor saving is presented. For previous articles see *Ceram. Abs.*, **7** [12], 828 (1928). E.J.V.

Building a brick-faced concrete arch dam. ANON. *Clay-Worker*, **90** [4], 284 (1928).—Faced on both sides with 4-inch vitrified brick, the concrete-arch Caneadea dam in western New York is unique. The purpose of the brick facing is to resist frost action and to prevent surface disintegration of the concrete. The dam also stands out as one of the few arches having gravity section concrete abutments. Both sides of the arch are brick-faced above the natural ground level, but no facing was put on the abutments or spillway walls. The bricks were laid in mortar, alternating headers and stretchers in each course, previous to placing the concrete. After the forms were removed, all joints were pointed and left flush with the face of the brick. The advantage of using the brick facing as water-tight forms was apparent from the start. While the newly laid brick facing was not strong enough to withstand the lateral pressure of fresh concrete, forms were necessary only to hold the brick in place. E.J.V.

Drain tile industry of Ohio. G. A. BOLE. *Clay-Worker*, **90** [4], 286–88 (1928).—The many uses of drain tile are discussed. The O. S. U. Engineering Experiment Station made a technical field survey of manufacture and a laboratory survey of the product. The object of the field survey was to determine the exact state of the industry from a technical standpoint and to determine of what service the Engineering Experiment Station could be to the industry. Ohio is the leading drain tile state, manufacturing 32% of the drain tile produced in the U.S. with approximately 1000 men employed. The production capacity in Ohio plants is about 268,000 T. The usual service conditions for tile are: that the tile must be sufficiently rugged to be handled reasonably roughly without damage; that they will not crush during filling when placed in the ditch; that they stand the soil water and weather conditions. The A.S.T.M. has set up 3 tests for quality: (1) strength test, (2) absorption test, and (3) freezing and thawing test. Forty-five tile were chosen as representative of the entire product of 12 plants selected after consideration of the following points: (1) geographical distribution; (2) size of plant; (3) clay used; (4) process employed; (5) character of product. All the Ohio shale tile tested fell into the classes known as Standard and Extra Quality, about 50% in each case; while the Ohio surface clay tile fell about 22% into each of those two classes and the other 56% in the Farm Drain Tile class. A few of the general conclusions drawn from data obtained in the tests made are as follows: (1) color of tile is in most cases a good indication of the hardness of firing as compared with other tile manufactured at the same plant, but cannot be depended upon in comparing tile from different sources; (2) tile made from surface clays are more porous than those made from a mixture of shale and fire clay or those made from shale alone; (3) there is an inverse relation between resistance to freezing and absorption, *i.e.*, tile having a high absorption capacity or porosity are poorly resistant to freezing; (4) there is an inverse relation between crushing strength and absorption, *i.e.*, tile having high absorption have low crushing strength. This statement is true regarding comparison of tile from different plants as well as between those from the same plant; (5) time and temperature of firing are important factors governing the absorption capacity of a tile. Either longer firings at the same temperature or higher temperatures over the same or longer lengths of time produce a more vitreous ware; (6) tile made from surface clays are more easily attacked by freezing agencies than those made from shale or shale-fireclay mixtures; (7) tile made from fine-grained material have a greater modulus of rupture than those made from coarser material; (8) lamination decreases load-bearing capacity and makes the product much more susceptible to weathering. Lamination is present in varying degrees in the product of all plants. Sandy clays show somewhat less lamination than do the more plastic clays; (9) nothing can be said as regards the effect of different manufacturing methods on the finished products; (10) data on absorption show that sandy surface clays give a product higher in porosity

than do the more smooth and plastic clays; (11) average tile are not noticeably affected by freezing and thawing until the process has been repeated a considerable number of times. Usually 30 or more freezings and thawings by the natural method are required to show any appreciable effect on the tile structure; (12) spalling increases with lamination, while cracking does not seem to follow the same trend. When pieces spall off rupture follows the layers of lamination, but cracking is usually at right angles to these layers; (13) tile seldom crack around the circumference but always in a longitudinal direction from freezing. E.J.V.

Brick construction in Florida storm. R. E. TILDEN. *Bldg. Econ.*, **4** [10], 1–18 (1928).—Brick, as usual, stood the test of the Florida storm better than any other form of construction. Two exceptions were plants of the Gulf Refining Co. and Florida Light and Power Co. at West Palm Beach, the only two failures seen during the investigation. Tile failures were numerous but the destruction of concrete block buildings was universal. E.P.R.

Erecting damp-proof tile-and-brick walls. P. H. BEVIER. *Eng. News-Rec.*, **100** [7], 285–86 (1928).—With careful workmanship and regard for recognized good practice, exterior curtain wall construction is satisfactory from a weatherproof standpoint. Raked-out or rough-cut mortar joints are common causes of leaking walls. Cross joints should be well filled, integral waterproofing should be used in mortar, and the back side of facing brick covered with enough mortar to fill the space between brick and tile. There should be no open space between face brick and tile backing. L.A.P.

Wind pressure tests on large model building. E. R. DAWLEY. *Eng. News-Rec.*, **100** [13], 508–10 (1928).—Wind pressure was found to vary with power of velocity slightly greater than the square. The exact formula for maximum pressure from this experiment is $P = 0.00176V^{2.05}$, or $P = 0.0022V^2$ at 125 miles per hr. Modern engineering practice designs structures to withstand lateral pressures of 20 to 30 lbs. per sq. ft. D. suggests that this could be increased to 35 lbs. per sq. ft., which would probably insure against a 125-mile gale. L.A.P.

Suitability of clay for drying. M. M. MINTER. *Clay Prod. News*, **1** [8], 8–9 (1928).—The safe drying rate for ware must be determined before the equipment necessary for a given capacity can be chosen. Some clays may have a very narrow drying range, but when once that difficulty has been surmounted they will stand almost any treatment in the kiln. M. has dried ware that required twice the length of time to dry safely as it did to fire and *vice versa*. H.H.S.

Chamber driers for brick and tile. ALFRED GILARDONI. *La Ceramique*, **30** [473], 218–23 (1927).—G. points out the importance of the drying process in the manufacture of brick and tile. The requirements of a modern drier are listed and the disadvantages of the old system of using drying floors are described. With certain raw materials, drying floors can still be used successfully if the air is reheated in winter. A general discussion of drying is given. Three factors should be taken into account in considering the action of the drying gases: temperature, volume, and humidity. All driers are divided into tunnel driers and chamber driers. G. subdivides chamber driers into (1) convection circulation, (2) induced draft, and (3) forced draft driers. Descriptions, operation, and advantages of the three types of chamber driers are then given in detail. The first two types do not allow as accurate control of the drying conditions as the last type, but can be used for certain types of product very satisfactorily. Transverse and longitudinal types of forced draft driers are described and the economies they make possible are pointed out. G. concludes that every effort should be made to use waste heat in the factories before recourse is had to other sources. A discussion follows. A.E.R.W.

Artificial driers for bricks. ANTOINE RAYMOND. *La Ceramique*, **30** [473], 223–27 (1927).—A description is given of a drier which was patented by Pierre Balbi. It consists of groups of four chambers arranged with interconnecting flues and valves so that the products of combustion of a furnace can be forced through the different chambers in turn and a chamber can be disconnected from the series when the material in it is dry. A discussion follows. Illustrated. A.E.R.W.

Blast-furnace slag bricks. ANON. *Iron and Steel Ind.*, **1**, 189–90 (1928).—Brief particulars are given of the application of the calcium silicate process for the manufacture of blast-furnace slag bricks. The slag in a fine state of division is mixed with 6 to 10% of slaked lime and a certain amount of water, and is compressed into shape, afterward being exposed to the direct action of steam at atmospheric pressure. The lime combines with the free silica or the unsaturated silicates present and forms an intensely hard brick. (*J.I.S.I.*)

PATENTS

Method of drying brick and tunnel therefor. CLAUD E. FULLER. U. S. 1,688,306, Oct. 16, 1928. An improved drier for brick and the like comprising a tunnel open top and bottom, an air heating chamber arranged parallel thereto, means for heating the chamber, a plurality of blowers spaced apart from the tunnel, and connected thereto, the blowers being so arranged with respect to the tunnel and the heating chamber as to cause a downward movement of heated air through a plurality of points in a tunnel simultaneously, and means for reheating the air prior to each downward movement.

Apparatus for measuring shrinkage of materials. FRANKLIN W. GUNTHER AND GEORGE P. FISHER. U. S. 1,688,330, Oct. 23, 1928. The combination with a material-drying chamber, of a rod projecting into the chamber and movable in accordance with variations in the dimensions of the material therein, and indicating means coöperating with the rod and enabling the determination of the amount of movement thereof, the indicating means including a resistance circuit, and means for varying the resistance therein.

Building brick. HALVER R. STRAIGHT. U. S. 1,688,902, Oct. 23, 1928. A brick of substantially rectangular formation, two of the opposite faces of the brick being provided with a series of intersecting grooves to form outwardly projecting members, the grooves being deeper at their central portions than at their ends, and so proportioned that the drying surface at the opposite faces will be gradually increased from their edges to their central portions.

Refractories

Physical structure of refractory materials. THOMAS S. CURTIS. *Jour. Amer. Ceram. Soc.*, **11** [12], 904–16 (1928).—The physical structure of the following refractory materials is discussed: (1) high-fire refractory bodies such as heavy duty fire brick for boiler settings, etc., flux line glass tank blocks, etc., in which the development of mullite is carried to a very high degree; (2) low-fire refractory bodies, such as saggers, glass tank specialties, etc., in which mullite plays a relatively unimportant part; (3) vitrified stoneware, whiteware, sanitary ware, and porcelain fired to temperatures that do not bring about the development of mullite except as an incidental inclusion within a globule of fused feldspar; and (4) the technique of natural color photography and photomicrography presented as a means of preserving a faithful and permanent record of the structures shown under the microscope. Five color plates are included.

English and German refractories industry. STUART M. PHELPS. Amer. Refract. Inst., *Tech. Bull.*, No. 25 (1928).—A review of impressions and information obtained on the Ceramic Tour Abroad is given. A description of some of the plants, processes, and products is given in considerable detail. F.P.H.

Temperature-property characteristics of refractories. J. F. Hyslop. *Blast Fur. Steel Plant*, **16** [10], 1357–60 (1928).—The thermal properties of refractories, especially those at high temperatures, are difficult to estimate but accurate data are essential if the efficiencies of modern high temperature plants are to be seriously considered. The principal data required in practice are the specific heat, heat capacity, conductivity, and temperature diffusivity, and the importance of any single characteristic will depend on the nature of the service the material is called upon to perform. In some cases high conductivity is required, while in others a low value may be desired, in each case the conservation of fuel being the objective. Other cases arise in which the heat capacity or the temperature diffusivity of the material may be the most important property. An excellent review of the thermal properties of refractories is due to A. T. Green. The specific heats of clay and silica materials are very similar even at high temperatures. The specific heat increases rapdily with temperature, and there may be as much as a 40% increase from 200 to 1000°C. This factor is basic in calculating heat balances for furnaces; its evaluation, although difficult, has always been a matter of importance. The heat capacity per unit volume of a refractory is a useful factor to have for comparative purposes. For normal substances it is the product of the specific gravity and the specific heat, but since refractories are generally porous, it is consequently the product of the apparent specific gravity and the specific heat. The apparent specific gravity of silica and clay materials at high temperatures decreases, often as much as 4%, but since the specific heat increases greatly with temperature rise, it is evident that temperature has a very appreciable effect on the heat capacity. The following table after Green illustrates this point:

Heat Capacity
(Calories per Cc.)

Temp. °C	Fire brick	Silica	Magnesite	Zirconia
100	0.400	0.349	0.621	0.470
1000	0.570	0.495	0.842	0.852

In addition to the constitution of the material, the porosity factor must be taken into account in a consideration of the conductivity. At low and moderate temperatures pore spaces act as insulators, and a highly porous brick has very low conductivity and is a good insulator up to 800°C. At high temperatures, however, the pores may contribute substantially to the heat-flow through the material, and data presented by Green indicate that at elevated temperatures the quantity of heat transmitted via the pores by means of radiation and convection by the solid material increases. Commercial insulating material, which is of great practical value in assisting to lessen furnace heat loss, owes its characteristic property of low thermal conductivity to the amount and nature of the pores in the material. In the case of diatomaceous earth materials the pores are generally very minute and evenly distributed, and such products have low apparent specific gravity, ranging from 0.35 to 0.75. For some purposes it is convenient to know the temperature diffusivity of a refractory, *i.e.*, the rate at which the material transmits temperature changes. The value is important in plants in which temperature is more important than total heat, *e.g.*, in coke oven, gas retort, and certain metallurgical furnaces. The coefficient of temperature diffusivity is derived from Fourier's diffusion equation, which states that the coefficient of thermal conductivity is equal to the product of the coefficient of temperature diffusivity and the heat capacity. Green has shown that the temperature diffusivity depends on the constitution of silica and clay materials. A badly fired silica brick has very low temperature diffusivity value, and at high temperatures cristobalite is superior to tridymite, but at lower temperatures the order is reversed for the latter two types of material.

Likewise, as might be expected, a well-fired clay body gives a higher value than a badly fired product. F.P.H.

Consumption of diaspore. A. F. GREAVES-WALKER. *Blast Fur. Steel Plant,* **16** [11], 1481–82 (1928).—The use of diaspore by the manufacturers of high grade refractories has increased during the past eight years until all of the large manufacturers depend upon this mineral for fire brick having pyrometric cone equivalents above 36. Diaspore first came into use for refractories about 1907. It was not until after the war, however, when the demand became insistent for super-refractories, that the industry at large began to take interest in the mineral. The only known commercial deposits are located in east central Missouri. They are confined to a relatively small area and the reserves available at the present time only slightly exceed 1,000,000 T. In this total is included all diaspore and burley clay which will analyze over 55% Al_2O_3. Of this total one large refractories company owns approximately 500,000 T. or one-half, the remainder being divided among 8 or 9 others. Within a few years the reserves of several manufacturers will have become exhausted and no source of future supplies of high alumina material has yet been found. Several possibilities offer a solution of the problem, among which are cyanite, bauxite, and Georgia kaolins. Cyanite ($Al_2O_3SiO_2$) has already been tested out commercially and is considered a valuable refractory. Practically all cyanite used in this country has been shipped from India and is of the massive variety. One mine in Va. has been producing a small tonnage for several years, but the large and practically inexhaustible deposits of this country are located in western N. C. It is these deposits which the refractories manufacturers will have to turn to if the use of cyanite becomes general in high alumina refractories. The use of bauxite ($Al_2O_3.2H_2O$), like cyanite, necessitates processing of the ores. A considerable amount of research work has been done on this mineral in an effort to use it for refractories. Because of difficulties encountered in the past an idea has become prevalent among some manufacturers that it is not suitable for the purpose. While it is true that shrinkage of bauxite brick in use has heretofore presented a serious problem, no manufacturer has been properly equipped to "dead-burn" the ore. That this can be done has never been questioned and the fact remains that very satisfactory refractories have been made from ore calcined at 2900°F. An additional 100° would make an even more satisfactory product. During the past 5 or 6 years the refractories manufacturers have been considering the future possibilities of the Ga. kaolins. The deposits extend in a wide band across Ga., from Augusta to Columbus, but not all of the clays are suitable for refractories. Only those classed as hard kaolins and those of the bauxite type will serve this purpose. While a large majority of the deposits have an alumina content ranging from 35 to 40% and a pyrometric cone equivalent of from 34 to 36, there are many containing bauxite clays which range from 41 to 56% alumina and having pyrometric cone equivalent of from 37 to 40, or practically the same as the diaspore clays. The shrinkage of these clays is higher than diaspore and it would be necessary to calcine from 60 to 70% of the batch to at least cone 20. This would necessitate rotary kiln treatment if the material was used on a large scale. F.P.H.

Spalling of refractories in oil-fired furnaces. ANON. *Blast Fur. Steel Plant,* **16,** [11], 1482–84 (1928).—An extensive review is given of the most recent observations and investigations on the subject. F.P.H.

Magnesite. HUGH M. HENTON. *Blast Fur. Steel Plant,* **16** [11], 1484–87 (1928).—Crude magnesite may be marketed as mined except for removal of lime carbonate and siliceous waste. More often the crude is calcined so as to give either "light-burned" or "dead-burned" magnesia. The light-burned is sometimes known as "caustic" and is the producer of a moderate kiln temperature. The dead-burned magnesia is

the product of a furnace temperature so high as to remove all carbon dioxide and give an incipient fusion if sufficient impurities are present. Methods of mining and sorting are described. No machine for sorting has been a commercial success. Occasionally there is only a very slight difference in appearance between a good magnesite and one containing high lime. This complicates the sorting problem. The dead-burned magnesite is often mixed with iron oxide (2 to 5%) in order to make a bond which will hold the particles together in small, nearly spherical globules. Sometimes the iron oxide is present in the crude magnesite as it comes from the mine or quarry. The kiln product is called "ferro-magnesite." The temperature for its formation is just above 1500°C. The magnesium silicate forms a binding material to hold magnesia and iron oxide. F.P.H.

Crucibles for melting glazes. ANON. Bur. Stand., *Tech. News Bull.*, No. 138, pp. 145–46 (1928).—In connection with the study of the physical properties of glazes which are being determined at the Columbus branch of the Bureau it was necessary to develop a crucible in which the glazes could be melted. The following batch formulas proved very satisfactory: (1) 35% calcined clay from Gordon, Ga. (G-3); fired to cone 20 and ground to pass 80-mesh screen; 5% felspar, 10% flint, 16⅔% G-3 clay, 16⅔% Ky. ball clay No. 4, 16⅔% English china clay; (2) 25% calcined G-3 clay prepared as above; 25% calcined alumina passed 60-mesh sieve; 16⅔% Fla. kaolin, 16⅔% Ky. ball clay No. 4, 16⅔% English china clay. After ball milling ½ hr. and casting in plaster molds, the No. 1 crucibles were dried, fired at cone 20, and allowed to soak 5 hrs. They were very good for the less corrosive glazes. The No. 2 crucibles were fired at cone 23 and soaked. These were used for the most corrosive glazes. Glazes containing as much as 30% B_2O_3 were satisfactorily melted with little attack on the crucibles. R.A.H.

Blast-furnace linings. ANON. *Brit. Clayworker*, **37** [438], 258–59 (1928).—Blast-furnace linings of best quality are made of a mixture of grog and clay. Two methods are in use: (1) the largest possible proportion of grog and the smallest possible proportion of clay, and (2) a small proportion of grog. The first requires a highly plastic clay and the second a refractory clay of low plasticity. The clay should be dried and finely ground. The grog used should be moderately coarse, as fine grog has a deadening effect and causes the brick to be weak and easily corroded. For most linings the grog should pass sieve holes ⅛ in. in diameter and none should pass a 50-mesh sieve. Large blocks may have somewhat coarser grog. After shaping by stiff-plastic or dry-press methods great care is required in drying. Driers having temperature and humidity control are more satisfactory than floor driers. The tunnel kiln is recommended for firing. The chief precautions are: (*a*) texture must be moderately coarse to withstand sudden changes in temperature and yet fine enough to resist corrosion by slag; (*b*) structure must be free from lamination usually due to a wire-cut machine or press; (*c*) sufficient clay must be used to produce a good "ring;" (*d*) grog must not be too fine; (*e*) mixing of materials must be thorough; (*f*) firing should be sufficiently prolonged to insure a good "ring;" (*h*) it is usually a mistake to use any other ingredients than clay, grog, and water. R.A.H.

Marketing of chrome ore. ANON. *Eng. Min. Jour.*, **125** [12], 495 (1928).—Buyers for the steel or ferro-alloy industries usually desire an ore containing not less than 45% chromic oxide and an iron content not exceeding one-quarter of the combined iron and chromic oxide content; *e.g.*, if the chromic oxide content is 45%, the iron must not exceed 15%. The chemical trade requires the Cr_2O_3 to be 50% or more and the iron limit given above may be exceeded by 1 or 2%. Refractory manufacturers demand low silica, generally below 5 to 8%. Ore of low Cr_2O_3 content is acceptable to the ceramic and brick industry although it does not command as high a price. As

low as 38% Cr_2O_3 is commonly accepted and even lower grades have been used. The refractory trades generally buy chrome ore with a guaranteed minimum content of Cr_2O_3 and with no premium for a better quality than is specified. A.J.M.

Uses of graphite. ANON. *Eng. Min. Jour.*, **125** [15], 567 (1928).—Before 1914 the manufacture of graphite crucibles consumed more than one-half of the supply of graphite; in 1923 only 15% of the graphite used in the manufacture of finished products was devoted to the manufacture of crucibles, and in 1924 only 13%. A.J.M.

Furnace maintenance and repairs. WALTER J. MAY. *Mech. World*, **84** [2166], 11–12 (1928).—Each furnace is designed for general efficiency, and any divergence in design causes loss. If the furnace lining wears away and bellies out and the exit flue wears, it takes more coke to melt the same weight of metal. The construction has an important bearing on maintenance. Parts exposed to direct action of the fire must be smooth, the bricks must have square edges, and joints must be the thinnest possible. The bricks have to be rubbed true and the jointing material must be sieved to eliminate lumps. In cupolas and other furnaces working under blast, a double lining should be used. Daubing should be done with finely ground ganister after chipping off all slag. In making repairs a smooth surface has to be produced and frequently bricks have to be reduced in thickness to make them agree with worn parts. With some types of annealing furnaces a very small change in parts will alter the operation; no change should be made in entrances or exits for the heated gases. In some reverberatory furnaces the roof is most troublesome and when renewals are made the original construction cannot always be adhered to because of difference in expansion of the new material causing bulging over a wide area. Occasionally, the bulging is so great that it is cheaper to reconstruct rather than to make large repairs. In all cases the materials used must be of about the same quality as the original. E.P.R.

Forging furnaces operated with powdered coal. C. REHFUSS. *Mech. World*, **84** [2169], 84–86 (1928).—For forging, powdered coal is better than oil, because it furnishes a softer and more penetrating heat and consequently less tendency to burn the steel. The most common design of furnace for steam-hammer and drop-hammer work is the 2-door type. The furnace shells are steel plates and the walls and arches are 9-in. fire brick. The doors are of cast iron, with monolithic lining. The steel stacks are lined with 4½-in. brick. The size of all flues leading to the stacks is such that a small amount of flame comes out around the doors. This prevents excessive heat loss in the stack. Advantages of this new furnace design are listed. E.P.R.

Scientific methods in furnace construction with hollow air-cooled walls. ANON. *Mech. World*, **84** [2172], 152–53 (1928).—One of the most important modern developments in furnace construction generally, and especially as regards water-tube boilers and the traveling grate stoker, is the suspended arch. Essentially, the principle is to construct the roof of the furnace in the form of a flat arch of special interchangeable firebrick blocks attached to overhead steel girders, which may be almost any size and strength. This represents a great improvement on the old-fashioned simple spring arch which allows only a narrow width and is costly in construction and upkeep. E.P.R.,

Refractories in power plants. R. A. SHERMAN. *Mech. World*, **84** [2174], 199–200 (1928); for abstract see *Ceram. Abs.*, **7** [4], 235 (1928). E.P.R.

Commercial sands. W. J. REES. *Refract. Jour.*, **3** [36], 947–48 (1928).—Sand specifications for foundry or other industrial uses are discussed. E.P.R.

Acid-resisting refractory bricks. ANON. *Refract. Jour.*, **3** [36], 952 (1928).—The General Refractories Co., Philadelphia, announces the development of a new refractory

brick which is highly resistant to acid attack. This brick will be marketed under the name of "Acido," and is intended primarily for use in zinc and copper plants. E.P.R.

Bricks and blocks for lime kilns. ALFRED B. SEARLE. *Refract. Jour.*, **3** [36], 963–64 (1928).—A discussion is given of the serviceability of different refractories for lime kilns. E.P.R.

Exploitation of high-silica rock. P. G. H. BOSWELL. *Refract. Jour.*, **3** [36], 968–70 (1928).—Although over 59% by weight of the earth's crust is silica only part of it is uncombined. "Free" silica in the anhydrous form (as quartz, chalcedony, flint, chert, etc.) and hydrated (as opal, geyserite, diatomite, etc.,) is plentiful. Sand is loosely associated quartz-grains; cemented together they form sandstone, quartzite, quartz-schist, etc. The outstanding physical properties of silica economically valuable are (*a*) hardness and absence of cleavage, and (*b*) refractoriness to heat. In glassmaking, soapmaking, etc., the physical properties are of less importance than the chemical purity which must be assured, but the grain size is of importance also. Quartz exists in two forms, α-quartz, which crystallizes below 575°C, and β-quartz, which crystallizes above 575 and below 870°C. The quartz of sands, sandstones, and most rocks consists mainly of β-quartz. Veined-quartz, the six-sided crystal form, is usually the α-variety. Tridymite and cristobalite, both having α and β forms, occur but rarely in nature. Chalcedony consists of a very fine aggregate of silica crystals only visible as individuals under the microscope. Opal consists of silica combined with water. Tripoli powder consists of opaline siliceous "skeletons" of tiny plant organisms known as diatoms. These are exceedingly small and when used as polishing powders have a gentle abrasive action; being cellular it is used for insulation, filtration, etc. Siliceous sinter (geyserite), loosely aggregated or compacted, is a finely divided form of silica deposited from solution, often near hot springs. Quartzose sands are those in which the grains of quartz are loose, and vary in size from 2 mm. to 0.1 mm. Sandstones are sands cemented together in all degrees of compactness. Ganister is a rock of this type with certain special physical characters. Quartzites are highly siliceous sandstones recrystallized. Quartz-schists also are metamorphic rocks. Fused silica ware is manufactured from aggregates of pure quartz crystals. For optical glass and crystal ware very pure materials are necessary. For lighting ware the standard demanded is rather less, while for window and bottle ware still less. Large quantities of high silica materials are used in the manufacture of steel and in smelting of other metals, for the lining of furnaces, cupolas, etc. They are also used in the foundries as constituents of molding sands as the essential requirement of such materials is their high resistance to heat. E.P.R.

Fire cement. ANON. *Refract. Jour.*, **3** [36], 970 (1928).—A very attractive booklet by the General Refractories Co., Ltd., describes "Pyrolyte" fire cement. This new jointing cement is "self-setting," *i.e.*, it sets "cold" without the application of heat. It "keys" onto the bricks and knits them into a monolithic lining. Its mechanical strength is such that two bricks set in it are only parted by a force of 45 lbs. per sq. in. Many other advantages are also claimed. E.P.R.

Combination ladle nozzle. ANON. *Refract. Jour.*, **3** [36], 975 (1928).—The Joseph Dixon Crucible Co., Jersey City, N. J., has recently introduced a new combination ladle nozzle. The upper half is made of a highly refractory clay and the lower half of graphite. Metal may leave this ladle at a lower temperature than ordinarily, due to the heat-retaining qualities of the graphite in the lower half of the nozzle. The new nozzle is made in any size to vary with the flow hole required. E.P.R.

Insulation of open-hearth furnace chambers. ANON. *Refract. Jour.*, **3** [36], 980 (1928).—The saving in fuel and other advantages to be derived from the use of

insulators on the checker chambers of open-hearth furnaces are discussed by L. B. Mc Millan in a recent issue of *Iron and Steel Engineer*. Graphs are given showing heat losses through uninsulated and insulated walls and roofs of generators for various thicknesses of brickwork and insulation. E.P.R.

Harbison-Walker Refractories Co. ANON. *Brick Clay Rec.*, **73** [10], 668–88 (1928).—The extensive building program of the Harbison-Walker Refractories Co. has been under way for more than a year, and involves the expenditure of several million dollars. Three plants, at Templeton and Clearfield, Pa., and at East Chicago, Ind., have been rebuilt, utilizing the latest and most efficient methods and machines. The remodeling program will mean a greater concentration of production in the newer, efficient units and the closing down of some of the obsolete plants. This will mean a higher quality product than was possible in the old plants. All the new units are being built with tunnel kilns. When this program is completed a large percentage of all firebrick production will come from tunnel kilns. The various features of new design and equipment are described in detail and illustrated. E.J.V.

Determining conductivity (thermal) of refractory materials. G. MÉKER. *La Ceramique*, **30** [474], 445–52 (1927).—After pointing out the need for a simple method for determining the thermal conductivity of ceramic materials, M. reviews the work of Vologdine and Bodin. M.'s apparatus was constructed with the needs of the furnace builder in mind and was designed to give values which could be translated into design work with the least trouble and uncertainty. Comparative values rather than absolute values were sought, and the tests were made on large specimens. In the apparatus, a block of the material under test, 200 to 400 mm. long and 55 x 55 mm. in section, was heated at one end by means of a Méker burner and temperatures at 10 points were read at frequent intervals. The heated surface of the test piece was maintained at certain temperatures and the changes in temperature of the other points followed. A photograph and diagram of the apparatus are given. The experimental results are given in graphical form. Data for the following materials are given: 3 fireclay bricks, 2 silica bricks, diatomaceous earth, bauxite, magnesia, silicon carbide, and 4 graphite bricks. Equilibrium gradient curves calculated from the data are also given. The significance of the results is discussed. A.E.R.W.

Load test of refractories. MINORU NAKAMOTO. *Jour. Jap. Ceram. Assn.*, **35** [418], 499–506 (1927).—A short history and literature on the development of the load test of refractories are given, particular attention being given to Steger's papers on the subject. S.K.

Sillimanite minerals in ceramic products. F. H. RIDDLE. *Chem. and Ind.*, **47**, 1151 (1928).—A lecture was delivered at Ottawa, Nov. 15, on the development of ceramic products manufactured from the sillimanite minerals and their possibilities in the chemical industry. H.H.S.

High temperature cements. ANON. *Proc. Nat. Elec. Light Assn.*, **80**, 144–45 (1923).—Three companies using high temperature cements carried on a series of experiments with various types and manufactures of so-called high temperature cements, *e.g.*, Thermolith, Hytempite, Adamant, Mecca, and Johns-Manville No. 304 Hot Blast Cement. Test results, advantages, disadvantages, and conclusions drawn from their use of these cements over periods of service ranging from ten months to several years are given. R.G.E.

Will steel replace fire brick? ANON. *Brit. Clayworker*, **36**, 71–72 (1927).—The possibility of using special nickel-chromium steels instead of fire brick for recuperator tubes, hearth-bricks, or zinc roasting furnaces, etc., is discussed. Both castings and forgings have already been used, and their increased strength and heat conductivity present advantages over refractories. (*J.I.M.*)

Gun for repairing furnace walls. ANON. *Iron Age*, **119**, 1309 (1927).—A gun for repairing furnace walls, made by the Botfield Refractories Co., Philadelphia, is described. It weighs less than 4 lbs., and is worked by compressed air at 50- to 80-lb. pressure, controlled by a regulating wheel. Firebrick cement mixed with suitable refractory materials is thrown onto the walls at a distance of 4 to 6 ft., a $^1/_8$-in. layer requiring 1 lb. material per sq. ft. The gun is marketed under the trade name of "Adamant." (*J.I.M.*)

Refractory articles in Tungsten powder. ANON. *Jour. four élect.*, **36**, 232–33 (1927).—Tungsten powder is moistened with warm water and a 10 to 12% aqueous solution of glucose. Excess moisture is removed by warming to 60 or 80°C. After being well mixed, it is compressed in a steel mold and dried at 350 to 400°C. It is finally heated to about 1600°C, W_2C or WC being formed according to the length of the firing period. The finished articles are of a gray metallic color with a melting point of about 2700°C, as registered by a Holborn-Kurlbaum optical pyrometer. (*J.I.M.*)

Electrical resistance of fire-resistant materials. ANON. *Metallbörse*, **16**, 2216, 2270–71 (1926).—A survey of work done by Rasch, Hinrichsen, Baumeister, Holladay, Eckert, Poole, Schiller, Joffé, Friedrich, Sittig, Ferguson, Burt-Gerrans, Kerr, Curtis, and others. (*J.I.M.*)

BOOKS

Industrial Uses of Bauxite. N. V. S. KNIBBS. Ernest Benn, Ltd., London, 1928. 141 pp. Reviewed in *Min. and Met.*, **9** [262], 474 (1928). F.P.H.

Practical Industrial Furnace Designs. M. H. MAWHINNEY. 318 pp. 104 figures, 28 tables. John Wiley & Sons, Inc., New York, 1928.—Contains chapters on fuel selection, furnace capacity, material handling, fuel economy, refractories, design of metal parts, furnace control, and practical problems in furnace design. Reviewed in *Blast Fur. Steel Plant*, **16** [11], 1487 (1928). H.H.S.

PATENTS

Checkerwork and brick therefor. ALBERT E. PETERSON. U. S. 1,687,786, Oct. 16, 1928. Checkerwork for regenerators comprising in combination a plurality of courses of brick extending in horizontal directions and placed in rows in vertical directions, the bricks being held in spaced relation with each other in the horizontal courses and arranged in spaced relation with each other in respect to each adjacent course in a vertical direction.

Fire-wall construction. MICHAEL LIPTAK. U. S. 1,688,192, Oct. 16, 1928. A wall having a permanent portion comprising a plurality of superposed channel irons, extending lengthwise of the wall, rows of fire brick laid upon the irons as headers and projecting at the inner side of the wall to form shelves, each header element having an I-shaped depression extending lengthwise and each header having an I-shaped bar loosely engaged in a corresponding I-shaped depression, and bricks filling the space between the headers and overlying the depressions.

Fused silica; heat insulators. BRITISH THOMSON-HOUSTON CO., LTD. Brit. 295,628, Oct. 10, 1928. A porous silica product which is impervious to moisture and of low specific gravity, is of use as a heat insulator for refrigerators, furnaces, or other thermal devices. Silica is made porous by heating and cooling, impregnated with an organic material, and then heated rapidly until plastic so that the organic material is volatilized and forms minute bubbles in the silica. In carrying out the invention, quartz sand is heated to about 1700°C, is kept at this temperature for about ½ hour, and is then cooled to room temperature. The resulting loose granular mass, which is either cristobalite or tridymite, is mixed with a shellac solution, is molded to shape, and is then heated slowly to about 400°C to evaporate the solvent of the binder and to

decompose and carbonize the shellac. The product is next heated rapidly to about 1750°C to eliminate the binder residue and to seal over the exterior surface of the molded mass. The binder leaves little or no residue and produces the multiplicity of small cavities which are not connected with one another so that the material is impervious to moisture. The material is stated to have a specific gravity of 0.6 or less.

Terra Cotta

Manufacture of stoneware and flower pots in a small plant. FRANK A. KIRKPATRICK. *Jour. Amer. Ceram. Soc.*, **11** [12], 896–903 (1928).—A brief description is given of the manufacture of household stoneware and flower pots in a 3-kiln plant in the Southwest and of improvements made in bodies, glazes, and processing.

Terra cotta glazed brick. ANON. *Brick Clay Rec.*, **73** [9], 618 (1928).—The Claycraft Mining & Brick Co., of Columbus, Ohio, is putting on the market a new type of face brick which is styled the "terra cotta glazed brick." The brick is made at the Shawnee plant of the company and shipped to Taylortown where a glaze is placed on them. The first of the brick came through several weeks ago and are being well received by the trade. The brick are intended not only for exterior work but for interior work where enameled brick have been customarily used. The cost of the new type of brick is considerably less than that of enameled brick. E.J.V.

Terra cotta figures. WALTER SUTER. *Pencil Points*, **9** [11], 742 (1928).—Illustration of two terra cotta figures executed by S. under J. H. D. Allen for a frieze in the Barnes Foundation, a gallery for modern art in Philadelphia. These examples of an adaptation of the art of Africa to American architecture are pastel black on a field of red glazed mosaic with border of golden buff and light green. They were exhibited by the Enfield Pottery and Tile Works at the Metropolitan Museum at the International Exhibition of Ceramic Art. E.B.H.

White Wares

Modernization in the pottery industry. ANON. *Ceram. Ind.*, **11** [5], 478–87 (1928).—Improvement in both periodic and tunnel kilns, and the steady increase in tunnel kiln installations are the outstanding features in the progress of the pottery industry. The Prouty kiln developed by the American Encaustic Tiling Co. and the new German tunnel kiln for the firing of hotel china, together with the increased use of electric kilns in the firing of both hotel china glost and tile glost, are important developments. The control of fire has been remarkably improved. A downdraft flat arch continuous tunnel kiln, known as the Benson downdraft continuous kiln, is in the process of construction for use in firing refractories, sewer pipe, face brick, building brick, hollow tile, pottery, general ware, vitreous china, electrical porcelain and insulators, sanitary ware, tank blocks, and terra cotta. A development in the manufacture of pottery which has already reached the commercial stage is the casting of dinnerware. In this process the clay slip is very carefully prepared, and it was found that only certain types of clays could be used in the body; the viscosity of the slip and pressure and length of casting are important. The molds used are in two parts, consisting of the face and the core. Small vents are employed to make castings perfect. Application of metallic glaze to the line and tie wire grooves is an innovation designed to reduce interference from insulators in radio reception. F.P.H.

Working properties of technical porcelain. HANDREK. *Keramos*, **7** [13], T5 (1928).—Two important fields of technology are preëminently served by porcelain because of its valuable working properties: the chemical industry and electrotechnology. Small susceptibility to chemical attack is combined in porcelain with high

electrical insulating capacity. In both fields of use its good mechanical and thermal strength enables it to reach high standards of requirements. Porcelain in both the glazed and unglazed state is extraordinarily resistant to the attack of most chemical substances. The strongest acids and the oxides of nitrogen and ozone originating from electrical charges have just as slight injurious effect as alkalis at ordinary temperatures and concentrations. Weathering of porcelain by atmospheric influences is absent even after decades. This is just opposite to the weathering of glass. Porcelain is only attacked by fluorine, hydrofluoric acid, a number of metallic oxides at glowing temperatures, and by alkaline melts. Among the many applications of porcelain for laboratory apparatus of all kinds, as a constituent of apparatus, container and lining material in the chemical industry, the use of porcelain spinning nozzles in the artificial silk industry should be mentioned. Such spinning nozzles can now be so cleanly and exactly manufactured with 1000 to 2000 bores of a diameter of 0.18 to 0.08 mm. uniformly distributed over a surface of 2.5 to 7 sq. cm. that a tolerance of the bores of 0.01 mm. can be maintained.

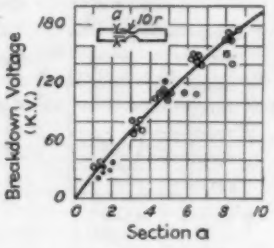


FIG. 1.

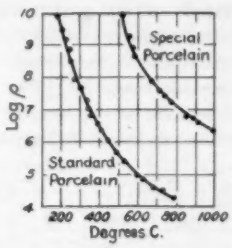


FIG. 2.

The electrical breakdown resistance of porcelain at ordinary temperatures depends upon the form of the electrodes and the thickness of the body (Fig. 1). Test plates for breakdown resistance measurement of the form represented in the figure are recommended. In contrast to most nonceramic insulation materials there is no perceptible difference in the electrical breakdown resistance of porcelain for a technical alternating current of 50 Hertz for short period and continuous loads. A prerequisite for high electrical breakdown resistance is a completely imperviously sintered body without macroscopic air inclosures. Porous porcelain is completely unsuitable for high tension purposes. For common cap insulators of 20-mm. body thickness an electrical breakdown resistance in the head of 130,000 volts is assured. The values obtained on testing attain 180,000 to 250,000 volts. The specific resistance (resistivity) decreases with increasing temperature to an extraordinary degree (Fig. 2). The electrical breakdown resistance similarly decreases with increasing temperature above 130°C. The conductivity of porcelain is of an essentially electrolytic nature. The surface resistance is not a property of the material, but depends upon the nature of the surface of the insulator and upon the humidity of the air. In contrast to the surface resistance (which at 30% relative humidity is 20 to 40 x 10^{12} ohm cm.) for glazed porcelain, the specific resistance of 10^{14} to 10^{15} ohm cm. may always be disregarded. With increasing air humidity the surface resistance decreases markedly (Fig. 3). High requirements are also made upon the mechanical and thermal properties of porcelain, especially in its use for high tension, free conducting insulators, where not only chemical and thermal demands but also demands occasioned by temperature change are simultaneously made. Since

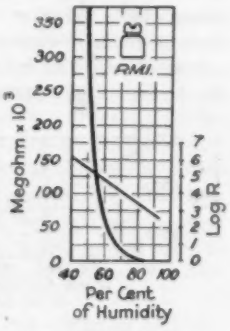


FIG. 3.—Surface resistance.

the tensile and cross-breaking strength of porcelain is only about $^1/_{10}$ of its compressive strength, it was therefore attempted to exclude demands upon the tensile and cross-breaking strength of porcelain insofar as possible in all construction, and to permit only compression and body requirements to occur. By the construction of exceptionally strong special bodies, and especially by the use of tensilely strong glazes it has now become possible to meet these requirements to a large extent in cap insulators for wireless telegraphy insulation and suspension insulators for electric railways. The glaze has a decisive influence upon all mechanical properties of porcelain as well as upon its resistance capacity to sudden temperature change (Fig. 4). Whereas unsuitably glazed insulators are already destroyed by a temperature drop of 50 to 70°C on testing, well-glazed insulators may be immersed without injury in liquid lead at 400°C, or may be heated by a luminous arc to a point where fluid, glowing, white masses of porcelain drop off. This experiment also shows that inner tensions are not present in satisfactory porcelain. High stability under temperature variation is especially important in the attachment of metal bolts to porcelain with the help of poured lead.

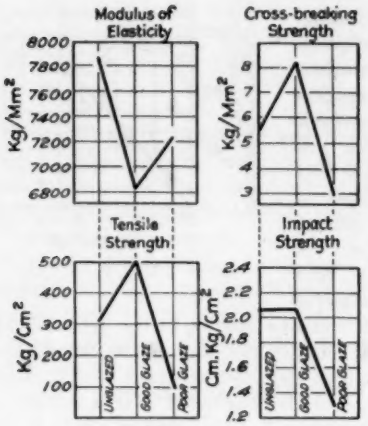


FIG. 4.

All the mechanical properties of porcelain are dependent upon the cross-section (Figs. 5 to 8) and the form and method of production of the body also have a definite effect. Insulators with numerous ceramic flounces therefore have smaller tensile and cross-breaking strength than correspondingly smooth porcelain caps of equal shaft dimensions. Likewise tube-shaped link types show a smaller specific cross-breaking strength than do massive bodies of equal cross-section. The specific strength decreases with increasing tube diameter and with the length of the porcelain body.

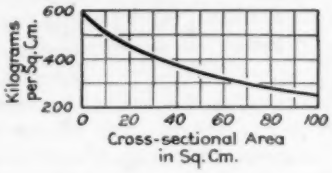


FIG. 5.—Tensile strength.

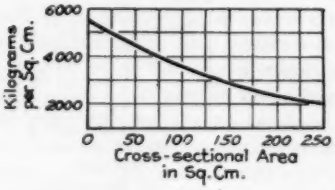


FIG 6.—Compressive strength.

The mechanical behavior of porcelain is further characterized by small tendency to wear and great hardness. The hardness is only slightly less than that of corundum (in Moh's scale of hardness, 7 for unglazed porcelain, 8 for the surface of the glaze). The mechanical behavior of porcelain is further characterized by the lack of capacity for plastic change of form (the elasticity limit practically coincides with the cross-breaking limit) and a higher sensitivity toward shock and impact effects than toward slowly occurring loads. The extent to which this brittleness of the material may be overcome is shown by the fact that full core insulators survive the test of several hundred blows of a suspended hammer of 1.5 m./kg. energy content while simultaneously subjected to a tensile load of 1000 kg.

Not all the desirable material properties can be combined in a single porcelain body. Much more frequently they stand in partial contradiction to each other. If, on the other hand, it is desired to develop only one property to the most possible degree of perfection at the expense of the other properties, surprising results can be obtained. The developments of recent years in modern operation are therefore characterized by the production of numerous bodies side by side and by the introduction of bodies for special purposes. In electrotechnical porcelain two chief groups are distinguished: (1) bodies with especially high electrical breakdown resistance upon whose use no excessively high requirements in mechanical strength are placed (*e.g.*, bodies for link types); (2) bodies in which the electrical properties are subordinated in favor of high mechanical strength. Because of the thickness of such bodies the electrical requirement is but small (*e.g.*, spark plug insulators and massive compression insulators for transmission tower). In contrast to the electrical breakdown resistance of standard porcelain introduced in Fig. 2 (measurements date back some years) important advances must be today recorded. The porcelain bodies for high tension porcelain at the Hermsdorf-Schomburg works have for 2-mm. thick plates of the form shown in Fig. 1 an average electrical breakdown resistance of 36 kv. per mm. as contrasted with 25 kv. per mm. according to Fig. 1, whereas special bodies on an average give values in excess of 40 kv. per mm. Bodies may be produced from mechanically high-valued porcelain, with omission of high electrical breakdown resistance, which are free from the proverbial fragility of porcelain to a high degree. Balls of 30-mm. diameter made from such bodies may be dropped upon thick steel plates from a height of 12 m. without suffering the slightest injury. Other special bodies manifest an especially high fire resistance and imperviousness to gas leakage. The "Freiberger pyrometer tubes" for thermo-elements are made from bodies of this kind. The strength values introduced in Figs. 5 to 8 (especially for cross-breaking strength and tensile strength) may be appreciably exceeded by the use of the special bodies. The same holds for the specific resistance of porcelain at high temperatures. This property is important for its use as an insulation support for heating furnaces and for electrical furnaces. The curve shown in Fig. 2 for the specific resistance of standard porcelain is compared with a curve obtained for special bodies. From exact measurements on suspension insulators in Sweden it has been established that a close relationship exists between the mechanical properties of an insulator and its suitability for operation and duration of life. The breakdown of an insulator in operation can usually be attributed to injuries of a mechanical kind; injuries of electrical origin, except from direct lightning strokes, are of less consequence.

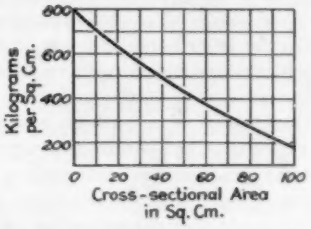


FIG. 7.—Cross-breaking strength.

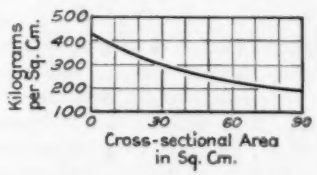


FIG. 8.—Torsional strength.

A gradual change in structure in operation due to continuous electrical and mechanical loads is not perceptible in high-valued porcelain. Suspension insulators have been in continuous operation for 24 years in Italy in the Cromo-Nembro stretch at a tension much too high according to our present views for the insulator type in question without having caused delays. Thin sections of these insulators show the same structure as sections of insulators which have lain unused during this time in storage. Such

investigations of the microscopic structure may be made in ordinary or polarized light or with X-rays. They extend to the determination of the number and size of the gas bubbles inclosed in the bodies, of the amount and condition of the quartz, of the amount and distribution of the crystalline phase (sillimanite, mullite), and give valuable data on the firing temperature and electrical and mechanical behavior of the basic porcelain. The opinion that the highest quality of porcelain is only attained if all the quartz is molten is thus shown to be as incorrect as the opinion frequently expressed that the content in crystalline constituents is a universal standard for the value of porcelain. A satisfactory prediction of the electrical and mechanical behavior on the basis of the investigation of microscopic structure is not possible in the present state of science. On the other hand, this test as an extension of the other electrical and mechanical investigations may furnish valuable hints. For the attainment of a high grade product factories have at their disposal a large number of control and testing methods. In the Hermsdorf-Schomburg works the raw materials and raw batch of the bodies and glazes used are continually supervised by chemical analysis. In this way variations from the standard composition may be adjusted. To guarantee the uniformity of the properties of the materials used, tests in the form of plates are taken from each firing for the determination of the electrical breaking resistance. Glazed tension bodies are also made for the testing of tensile strength. Preliminary tests are made on each relatively large glaze composition for suitable mechanical and thermal properties before it is used. It is thereby possible to recognize and exclude certain errors which may creep into the manufacturing process before they are able to assume larger dimensions. These progressive tests which must combine simplicity of execution with dependability of results are amplified from time to time by investigations of all the chemical and physical properties of the material insofar as they are of practical interest. Here also enter further scientific investigations for improvement of the properties of the material and for special purposes.

In addition to the manufacturing electrical tests in the testing fields tapping sample tests are made on all types of finished products in the Hermsdorf-Schomburg works. Every insulator and every individual part of the insulator is subjected to these tests. Tension insulators and assembled bodies constitute an exception to this rule. They are mechanically tested, piece by piece, before assembling. The various types of tests include: the determination of (1) high frequency tension under the conditions of varying conductivity in dry and rainy weather in certain instances in the solid state (*e.g.*, by soot, cement dust, salt, etc.), in mist, and in an atmosphere of acid and alkaline vapors; (2) electrical breakdown tension at technical frequency, impact tension, and high frequency requirement at 30,000 and 250,000 Hertz; (3) strength under simultaneous electrical and mechanical load; (4) compression, tensile, cross-breaking, and torsional strength; (5) resistance to temperature change; (6) porosity at 150 to 300 atmospheres pressure; (7) resistance to the luminous arc, either by tests with the stationary luminous arc or by immersion in liquid lead; (8) toughness by impact test with a falling under simultaneous tensile load; (9) dropped stone strength in a dropping apparatus of 10-m. height of fall and 120-g. stone weight; (10) resistivity to vibration loads in the vibrating machine at 15 to 1000 periods per minute and simultaneous tensile load up to 5000 kg.; (11) continuous load tests of various kinds with simultaneous electrical tension testing. To characterize the high level of the electrical porcelain industry several strength values for high tension insulators may be given. In modern cap insulators of 140 mm. porcelain high and 280 mm. plate diameter, for a guaranteed breaking strength of 6500 kg. per member, there is obtained an average breaking strength of 10,000 kg.; for a larger type, the so-called giant insulators, in excess of 20,000 kg. A compression insulator for the foundation insulation of antenna masts has for 20-cm.

diameter and 10-cm. height a full breaking strength of 600,000 to 700,000 kg. These values become clear when one considers that according to these values a single cap or full core insulator would be able to support one or two railway cars weighing 10 T., and that the weight of two 210-m. high antenna towers of the Nauen Gross station, together weighing 500,000 kg., is not sufficient to bring this compression insulator to the breaking point. F.P.H.

Insulator depreciation. J. C. MARTIN. *Proc. Nat. Elec. Light Assn.*, **79** [2], 1114–17 (1922).—Detailed reports are given of three cases of pin type insulator depreciation in service lines. Most failures are traceable to obsolete designs or incorrect insulator applications. Recently, manufacturers have made great advances in the design and fabrication of pin and suspension type insulators. R.G.E.

Insulator research. H. J. RYAN. *Proc. Nat. Elec. Light Assn.*, **79** [2], 1117–21 (1922).—Thermal fatigue tests were performed on suspension insulators. Insulator samples were subjected to accelerated temperature cycles using electric heaters and forced ventilation for cooling. The apparatus is described. The cycle was of one-hour duration (30 minutes heating and 30 minutes cooling). The object was to give the units a temperature range corresponding to the maximum daily range likely to be experienced in practice or about 130°F. To further simulate service conditions, the insulator strings were subjected to a mechanical load of 2000 lbs. The test specimens were run through 3650 cycles or an equivalent in cycles to 10 years' actual service. Conclusions: (1) fatigue in porcelain does not occur in 3650 cycles; (2) large temperature differences throughout the body of the porcelain insulator cause no apparent damage; (3) a mechanical load of 2000 lbs. caused no trouble; (4) cement when thoroughly dried materially decreased in volume. The decrease in volume due to this drying out of the cement loosens the insulator studs of a majority of the cemented units and thus eliminates any stress being transferred to the porcelain due to the difference in the expansion coefficients of the metal stud and porcelain body of the insulator. Tables of results and heat cycle curves for each type of insulator are given. R.G.E.

Insulators. J. C. MARTIN. *Proc. Nat. Elec. Light Assn.*, **80**, 674–80 (1923).—A statement of the year's development in the field of insulator use and methods of maintenance. Precautions to be observed in the use of cemented thimbles and in the choice of the type of fasteners used to secure conductors to insulators are given. The importance of carefully mixing the cement to be used in insulator assembly is emphasized. R.G.E.

Insulator research. J. A. KOONTZ. *Proc. Nat. Elec. Light Assn.*, **80**, 681–83 (1923).—The development and improvement of insulator manufacture is traced. The introduction of sillimanite to replace quartz, the relation between tensile strength and cross-section area of porcelain, the use of fused quartz, the effect of salt solutions, and the cement question are mentioned. A study of cement expansion is being conducted from the following standpoint: (1) Moisture absorption and consequent volumetric change and (2) thermal expansion and contraction. A bibliography on insulators accompanies the article. R.G.E.

Temperature shock tests on insulators. A. HERZ. *Proc. Nat. Elec. Light Assn.*, **80**, 684–87 (1923).—A quick method of determining the probable temperature shock-resisting qualities of high tension porcelain which has shown very consistent results has been made use of by the Public Service Co. of Ill. The process is a destructive one; *i.e.*, no insulator survives the tests. The insulators are graded according to the number of shocks they resist. The method of testing involves the heating of the insulator in a specially constructed oven (described), plunging into water, and when surface dried, testing for flashover. This procedure is repeated, the oven temperature being

raised 10° each time, until electrical failure of the insulator is obtained. Tables are given showing dry flashover, wet flashover, number of shocks to cause failure, location of failure, character of failure, and the temperature of oven above that of cooling water at time of failure. R.G.E.

Deterioration of porcelain. ANON. *Proc. Nat. Elec. Light Assn.*, **82,** 1613–14 (1925).—Deterioration of porcelain has been suspected by some to be due to the Piezo-electric characteristic of quartz. This Piezo-electric property is such that a quartz crystal changes its shape when placed in an electric field. Tensional and compressive stresses result, which in intense high frequency fields will cause a quartz crystal to shiver itself to pieces. Evidence of deterioration due to such effects appears negative since thin sections of porcelain taken from insulators and examined under the petrographic microscope showed no evidence of rupture of the quartz grains. R.G.E.

Insulators and protective devices for insulators. J. P. JOLLYMAN. *Proc. Nat. Elec. Light Assn.*, **83,** 958–59 (1926).—Condensed statements are given by six insulator manufacturers and others interested in the development of insulators and protective devices. The material covered involves causes and correction of trouble from cracking of the heads of pin type insulators, losses resulting from cementing in of improperly rust-proofed material, causes of arc over failures, and expansions of insulator cements. Most failures not chargeable to the insulator have been due to porous porcelain and internal stresses set up by electrical expansion between the various ingredients in the assembly, *e.g.*, steel, cement, and porcelain. Arc over failures may be caused by either excess voltage or by mechanical deterioration or dirt so accumulating on the insulator surface to reduce the insulation that breakdown occurs at normal voltage. R.G.E.

Expansion of cement. ANON. *Proc. Nat. Elec. Light Assn.*, **83,** 959 (1926).—Work being done at Westinghouse Electric and Mfg. Co. on the expansion of insulator cements is outlined. The work is following two phases: (1) the prevention of volume changes of the cement and (2) means of minimizing these effects by features of assembly. The work done shows that the volume change of the cement is more important than the thermal characteristics of the porcelain and that failures of pin type insulators attributed to the thermal characteristics were due to the effect of the cement action. R.G.E.

Long time strength tests of insulators. ANON. *Proc. Nat. Elec. Light Assn.*, **83,** 963–65 (1926).—The object of this investigation was to determine what relation, if any, exists between the ultimate mechanical strength of high strength suspension insulators, and the load which they can sustain indefinitely without electrical or mechanical failure. Five insulator manufacturers furnished samples and loads of 9000, 11,000, 13,000, and 15,000 lbs. were chosen for the tests. Quick time ultimate strength tests were also made. A description and sketch of the test rig are given. Results are given in tables and shown graphically. Examination of the insulators after fracture showed that there was always a cleavage through the path where electrical failure had previously occurred. Conclusions: (1) The quick time ultimate mechanical strength cannot be relied upon as a criterion upon which to base working load, the relation between the two depending upon either design or material, or both. (2) Incipient mechanical failure occurs at the time of electrical failure under load and will probably be followed by complete mechanical failure at some subsequent date without increase of load. (3) At some period during the long time test of 11,000 hours, the average ultimate mechanical strength of all insulators loaded up to 9000 and 11,000 lbs. decreased some 7 or 8%. R.G.E.

Porosity of porcelain and dye penetration. ANON. *Proc. Nat. Elec. Light Assn.*, **83,** 965–68 (1926).—The pressure and length of time of its application necessary to show up porosity in insulator porcelain were determined. Porcelain specimens of

standard degrees of porosity were obtained from insulator manufacturers and fired, factory practice being observed as well as might be on a small scale. Tables are given showing records of firings, microscopic examinations, mechanical strengths, and dye penetrations. Conclusions: (1) Ware of the description and dimensions experimented with becomes nonporous to pressures up to 25,000 lbs. per sq. in. maintained for 48 hrs., at a firing temperature corresponding to about cone 5 down. (2) A difference of about half a cone in firing temperature makes the difference between nonporous and porous porcelain. (3) There is not enough evidence to establish a definite relation between pressure, time, and penetration, as the slight differences observed may well be due to small differences in porosity of the specimens themselves. (4) There appears to be small danger of porous porcelain in insulators made of such ware as was furnished for the tests, as the factory firing schedule is several cones higher than the point of nonporosity. (5) Detection of porosity by temperature rise (or power loss) in a high frequency field appears to be a promising method and with recent improvements in high voltage wattmeters it may soon be possible to measure losses on assembled insulators upon a commercial scale. R.G.E.

Report of standard Zettlitz kaolin test. ANON. Bur. Stand., *Tech. News Bull.*, No. 138, pp. 146–47 (1928).—At its Copenhagen meeting the International Union of Pure and Applied Chemistry voted to undertake the preparation and distribution of an international standard sample of Zettlitz kaolin and charge the Ceramic Society of Czechoslovakia with the duty of carrying out this resolution. Samples of this standard have been distributed to the countries belonging to the union for analysis and testing and it is hoped that a comparative study of the results obtained will lead eventually to the adoption of international methods for the analysis and testing of clays for ceramic purposes. The present report contains the results obtained in the study of the standard kaolin at the Bureau of Standards made in accordance with the methods adopted by the AMERICAN CERAMIC SOCIETY and other methods in use at the Bureau. A very complete chemical analysis is given in addition to all the usual physical tests. The clay was fired to cones 2, 4, 6, 8, 10, 12, 14, 16, and 18 and comparison of physical properties made with a mixture of 50% clay and flint. The properties determined after firing at cone 12 are listed. R.A.H.

Thermal expansion of pottery bodies. TOSAKU YOSHIOKA. *Jour. Jap. Ceram. Assn.*, **35** [417], 459–63; [418], 506–10 (1927).—The relation between heat treatment in clay working and strength of the products, thermal endurance of potteries, and thermal expansion of bodies and glazes are explained. The literature on the thermal expansion of pottery bodies is given and discussed. S.K.

Measuring thermal expansion of pottery body. TOSAKU YOSHIOKA. *Jour. Jap. Ceram. Assn.*, **35,** [419], 568–72 (1927).—Classification of dilatometers and a special feature of each are given. A dilatometer which has been used in his experiments is described. It consists of a silica tube, a mechanism to rotate a mirror, a lamp, and a scale. A complete description of the apparatus is given. S.K.

Fibrous structure of porcelain bodies. RYOICHI SHIGEMUNE. *Jour. Jap. Ceram. Assn.*, **35** [420], 615–21 (1927).—In previous studies made of microstructure of porcelains, S. observed that fibrous crystals were developed so well as to show double refraction only in a specimen of Aizu-ware among about 130 domestic and foreign wares. Usually, they are extremely minute and are found in groups. In most cases, the groups include round pores and their outlines indicate the original shape of feldspar grains. Their coefficient of refraction varies from 1.48 to 1.49. The present report deals with the results obtained from a further study on the subject. Experiment 1: The microstructures of porcelain bodies with fine feldspar grains passing through a No. 200 sieve have been studied. In this case, the original shapes of feldspar grains were rarely shown and the

development of the fibrous structure was poor. Experiment 2:3 bodies composed of 30% orthoclase of the Hakuho Island of 50- to 80-mesh size and 70% Korean kaolin (Body *A*), kaolin-quartz mixture corresponding to Al_2O_3, $20SiO_2$ (Body *B*) or C.P. alumina (Body *C*) were fired at 1350 to 1370°C (cone 12 +) for 67, $23^1/_2$, or $8^1/_2$ hrs. The microphotographs of the specimens show that the fibrous crystals were universally developed in the feldspar grains in the specimens which were fired long and had suitable groundmass. The fibrous structure was developed best in the Body *B* fired for 67 hrs., whereas no crystals were observable in the Body *A* fired for $23^1/_2$ and $8^1/_2$ hrs. and all specimens of the Body *C*. According to G. W. Morey and N. L. Bowen (*Amer. Jour. Sci.*, **4**, No. 19 (1922)), artificial potash feldspar dissociates into leucite and glass at 1170°C, completing its fusion at 1530°, and these temperatures for a Carolina microcline are 1180 and 1440°, respectively. The fibrous crystals in porcelain bodies are probably leucite, $K_2O\ Al_2O_3\ 4SiO_2$. Its formation is most influenced by the time of firing and the nature of groundmass. As Morey and Bowen say, long heating is necessary for the formation of leucite. This is probably due to the viscosity of feldspar which is lowered by long heating. The effect of the nature of the groundmass is not chemical but is entirely physical. The most favorable influence of the highly siliceous groudmass in the Body *B* is due to its lowest viscosity which shall allow the effective development of the fluidity of the orthoclase grains and shall thereby aid in the formation of the fibrous structure. S.K.

Theoretical considerations on thermal expansion of pottery bodies. TOSAKU YOSHIOKA. *Jour. Jap. Ceram. Assn.*, **36** [421], 11–19 (1928).—The literature pertaining to the thermal expansion of pottery bodies, clays, quartz, tridymite, cristobalite, silica glass, and feldspars, the transformation of crystalline and amorphous silica, volume changes occurring in the transformation of the modifications, and the influence of porosity and grain size on the thermal expansion of the bodies are reviewed and discussed. S.K.

Breakdown of spark gaps. J. SLEPIAN. *Elec. World*, **91**, 761 (1928).—The great speed of breakdown of spark gaps at atmospheric pressures observed experimentally, contradicts sharply the classical Townsend theory of sparkover, which calls for 10^{-5} seconds. To solve this S. suggests that the thermal ionization of the gas takes place in the single passage of an electron from cathode to anode, and before the T. process can develop. Calculation, taking the space-charge into account, confirms this view. Sparkover takes place at those gradients which produce thermal ionization, and good agreement is obtained between breakdown gradients calculated on this basis and those observed experimentally. The "suppressed discharges" figures of Torok (*Trans. Amer. Inst. Elec. Eng.*, **1928**), which are difficult to explain otherwise, are a natural consequence of the theory of S. The time for breakdown with moderate overvoltages is of the order of 10^{-7} seconds. (*C.A.*)

Joffés studies on electric breakdown strength. P. JORDAN. *Naturwissenschaften*, **16**, 460–62 (1928).—A review of Joffés recent work on the mechanism of insulation breakdown. (*C.A.*)

PATENTS

Design for lavatory bowl. CHARLES B. NASH. U. S. 76,700, Oct. 23, 1928.

Design for lavatory. FRED W. FRANKENBERGER. U. S. 76,745, Oct. 30, 1928.

Design for lavatory. CHARLES B. NASH. U. S. 76,760, Oct. 30, 1928.

Insulator. CHESTER S. GORDON AND JAMES T. LOWE. U. S. 1,687,495, Oct. 16, 1928. An insulator for transmission conductors comprises a unitary mass of dielectric material of a generally cylindrical form having grooves in its outer surface for the accommodation of electrical conductors, and an interiorly screw-threaded opening for mounting the insulator upon a flanged pin, the diameter of the opening near one of the external grooves being somewhat greater than the diameter of the supporting

pin at that point, so as to provide an air-gap between the conductor mounted in the groove and the pin, the insulator being provided with a shoulder for co-operation with the corresponding flange upon the supporting pin, and the length of the interior opening above the shoulder being somewhat longer than the length of the pin above the flange, so that when the insulator is screwed upon the flange with the shoulder resting upon the flange, a small air-space will be provided between the upper part of the pin and the material of the insulator in the neighborhood of the upper groove.

Electrical insulator. WILLIAM S. COOK. U. S. 1,688,411, Oct. 23, 1928. A turned insulator having a circular head and a circular skirt below the same of much greater diameter, the head being provided on its top with a transverse line wire groove in the vertical axis of the insulator and being further provided with an encircling circular flange forming a side wire groove between itself and the skirt, the flange being upwardly curved from points at the sides of the line wire groove to a point in alignment with the latter and intersecting the plane thereof.

Insulator. CHRISTIAN AALBORG. U. S. 1,689,906, Oct. 30, 1928. (1) An insulator unit comprising a dielectric column and metal terminal members therefor, one of which is constructed as a single integral piece of substantially uniformly-thick sheetlike metal embodying a central mechanically-anchoring and electrostatic-stress-distributing portion of cup-shape extending into the column having a transverse inner-end wall and a rounded inner-end perimeter, an annular end supporting-base portion projecting laterally from the mouth of the cup and an annular flange projecting from the supporting-base portion toward the other terminal member a distance less than the inner end of the cup for mechanically protecting the end of the dielectric column, assisting in controlling the electrostatic field of the insulator and constituting attaching means. (2) An insulator comprising ceramic dielectric and metallic terminal elements providing an inclosed space, and a dielectric filler material capable of flowing and having a dielectric strength greater than air entirely filling the space, one of the elements having a relatively small breathing opening for the filler material.

Insulator. MINOR F. H. GOUVERNEUR. U. S. 1,690,291, Nov. 6, 1928. Means for connecting insulators having curved insulating passages comprising a pair of similar curved yoke members adapted for insertion through the interlinking passages of successive insulators and terminating in heads adjacent constricted neck portions, and connecting members apertured for the reception of the neck portions and having retaining surfaces co-acting with the heads, the connecting members including intermediate transverse portions spaced from the ends thereof to provide apertures for securing means.

Molding teapot lids, etc. W. COULTER AND P. BENNETT. Brit. 295,821, Oct. 10, 1928. Lids or covers, for teapots, etc., of the kind having the knob sunk in a recess are molded by means of a domed die adapted to form the recess and associated displaceable die sections adapted to form the knob.

Pottery making. W. J. MILLER. Brit. 296,084, Oct. 17, 1928. Turning and finishing means for pottery ware comprises a chuck adapted to automatically grip the ware and mounted on transfer apparatus whereby it is moved within operative adjacency to turning and finishing tools, rotation being imparted either to the tools or ware or to both such members. The transfer apparatus is mounted above a drier which contains the shaping-mechanism for operating on the intermittently-moving molds.

Equipment and Apparatus

Chromium plating valve. ANON. *Abrasive Ind.*, 9 [11], 311 (1928).—A new device for controlling the temperature of chromium plating tanks has been developed by

the St. Louis Motor Valve Co. The device is electrically operated and may be installed with ease. E.P.R.

Modern lifting machinery. I. E.K.W. *Mech. World*, **84** [2166], 8–9 (1928).—Various special types of cranes are described in this series, including ingot handling cranes, underhung or inverted job traveling cranes, furnace and ladle cranes, semiportable cranes, Goliath cranes, travelling cranes, etc. E.P.R.

Soot blowers for boilers. FAIRFAX. *Mech. World*, **84** [2179], 325–26 (1928).—Removal of soot, flue-dust, and fine ashes from boiler-heating surfaces can be accomplished at little expense while the boilers are in operation. The brickwork flues should be kept free from deposits of flue-dust to maintain efficiency. Flue-dust can be removed by jets of steam directed across the boiler between several rows of tubes simultaneously while the boiler is under steam with fuel burning on the grate, and with the furnace doors shut and dampers open. Soot and flue-dust are removed from brickwork flues of boiler settings and from main flues while the boilers are under steam by blowers located at various points along the flues, and operated in sequence, carrying resulting accumulations forward along to the chimney, stive chamber, or dust collector situated between the main flue and the chimney stack. E.P.R.

Efficiency and economy of colloidal mills. FELIX HEBLER. *Chem. Fabr.*, **40**, 581–82 (1928).—H. describes milling methods for obtaining colloids giving power consumption, fineness, and output of several tests and shows that a certain amount may be reduced to colloidal matter by small power consumption; further reduction requires considerable power. We are still far from possessing a "colloidal mill." T.W.G.

Acid control. ANON. *Ceram. Ind.*, **11** [5], 490 (1928).—The Palo acid-alkalimeter is a control instrument which determines p_H (acidity and alkalinity) directly, continuously, and automatically. The instrument is very satisfactory, both as a laboratory and plant process control instrument. In the latter capacity it is simple to operate and does not require the services of an expert to make the readings. If electrodes are placed in the vats, tanks, etc., located in various parts of the plant and connected by wire to the indicator, the acidity and alkalinity of the contents can be read off on the indicator located in the laboratory or some other convenient place. F.P.H.

Motors for use in explosive atmospheres. ANON. *Min. and Met.*, **9** [263], 521 (1928).—A line of both alternating and direct-current motors, built for use where explosive gases, fumes, or dust are present, is announced by the General Electric Co. and approved (as a result of tests) by the Underwriters' Laboratories for such conditions. The motors bear the G.-E. designation "Class BU Form JA" and are totally inclosed. The object of the special construction is to reduce the danger that heat (generated inside the apparatus by sparking or explosion) will be transmitted to the outside in such intensity as to ignite any gases surrounding the equipment. A two-piece cast-iron exterior is provided heavy enough to withstand the pressures of an internal explosion and with flanged joints sufficiently wide to cool the flame of any such explosion. No gaskets are used, as it is not intended that the motors should be gas-tight. F.P.H.

Clarkson flexible rail. ANON. *Min. and Met.*, **9** [263], 521 (1928).—The Clarkson flexible rail is designed to enable a track-mounted loading machine to clear up wide places in mines and quarries. With it a curve can be placed in the track on a moment's notice, exerting a small amount of energy. It is made up of small cast-steel sections with stop ears attached which rest in chairs mounted on cross-ties. The chairs also have stop ears which hold the small rail sections from coming apart. Usually the flexible rail section is attached or inserted about one or two rail lengths from the end of the track. The two curves automatically take care of their own expansion and

contraction, that is, the inside rail sections take up, while the outside rail sections let out, thereby forming a uniform curve. F.P.H.

Effective slurry mixing. A. ANABLE. *Rock Prod.*, **31** [22], 50–53 (1928).—The mixer described has been developed especially for mixing cement slurry. Its features are (1) mixing in two planes (horizontal and vertical); (2) positive return of deposited solids to suspension in the slurry; (3) effective agitation over complete area of tank; (4) reliable air agitation without difficulty from fouled nozzles; (5) low power consumption. F.P.H.

New process salvages waste mica. ANON. *Rock Prod.*, **31** [22], 68 (1928).—Salvaging of thousands of dollars of materials formerly lost is a new process for recovering mica from kaolin clays in western N. C. Geologist H. J. Bryson says: "Mica has always been considered a menace to the clay industry and the process of extracting the fine mica has been a very complicated one. Mica, a waste product, has been permitted to go down the streams and has always been considered as of no value. Now scrap mica, varying from 20- to 200-mesh, is recovered and sold at prices ranging from $20 to $120 per ton." F.P.H.

"Mesh" vs. "opening." ANON. *Eng. Min. Jour.*, **125** [7], 307 (1928).—A clear distinction must be recognized between "mesh" and "opening" (or "space") before an intelligent specification for wire cloth can be written. Mesh is measured from center to center of wire; opening is the space in the clear between wires. The only absolutely accurate designation for the user of screens is the width of opening between wires, and the diameter of wire, both in decimal fractions of an inch. A.J.M.

Development and advantages of disk crushers. I. W. T. W. MILLER. *Eng. Min. Jour.*, **125** [11], 449 (1928). **II.** *Ibid.*, **125** [12], 492 (1928). A.J.M.

Vibrating mechanism for screens. E. T. KEENAN. *Eng. Min. Jour.*, **125** [15], 618 (1928).—This mechanism involves a rotary electromagnet which alternately attracts and repels a pole fastened to the screen. A sketch of the apparatus is given. A.J.M.

Back pressure. ANON. *Brit. Clayworker*, **37** [438], 265 (1928).—In brickworks with hot-floor driers heated by exhaust steam the heating is often unnecessarily costly because of the back pressure on the engine. If the exhaust steam were to be discharged directly from the engine into the atmosphere without any intervening pipe or baffle, there would be no back pressure and the whole of the pressure of the steam would be used in the engine. If on the other hand a great length of pipe with several bends and valves and the flues beneath a floor is interposed between the engine and the atmosphere, a considerable amount of back pressure will be created, and this will reduce the efficiency of the engine to an extent rather greater than the back pressure. One means of avoiding this loss is to increase the pressure of the steam supplied to the engine by an amount slightly in excess of the back pressure. The ideal condition would be reached if all the power were developed by a turbine, because the power generated by a back-pressure turbine is less expensive than any other steam power, provided the exhaust can be utilized. With ordinary brickyard boilers and engines the initial pressure is limited to about 120 lbs. per sq. in., and therefore back pressure should not exceed about 6 lbs. per sq. in. In most works this is ample for driving the exhaust steam through the drying floor. The common practice of using live steam at high pressure in hot floors is very wasteful. A pressure not exceeding 10 lbs. is ample for this purpose. R.A.H.

Sodium aluminate for softening water. EDWIN C. ECKEL. *Eng. News-Rec.*, **100** [16], 616 (1928).—Substitution of sodium aluminate for alum at the water-softening plant of Hinsdale, Ill., has been satisfactory. It is not as expensive as alum and is more effective. Sodium aluminate used with lime and soda ash reduced hardness in water, due to high magnesia content, without an excess of alkalinity resulting. Better coagulation and a faster reaction were obtained by using sodium aluminate rather than

alum with the caustic soda and lime. There was also less scale on walls of filters and basins following its use. L.A.P.

New tool material. ANON. *Glass Ind.*, **9** [11], 262 (1928).—Cutting a screw thread in a glass rod, boring a smooth hole in a block of concrete, handling porcelain on a lathe, and cutting the hardest of steels can all be done easily with a new kind of machine tool material announced by S. L. Hoyt of the research laboratory of the General Electric Co., at the annual convention of the American Society for Steel Treating at Philadelphia, Oct. 11. The new material named carboloy, is composed of tungsten carbide and cobalt, the carbide being extremely hard and the cobalt giving it the necessary strength for cutting tools. The tungsten carbide tool quickly cuts into a glass rod, and can even be used for cutting a screw thread into it. Likewise, hard porcelain insulators can be machined on a shaper with the new material. Hardness is the notable physical property of carboloy. It scratches glass as a diamond does. The Rockwell tests showed that a common hardened tool steel has a maximum hardness of 850 on the Brinell scale, that the hardest steel may be taken as about 1000, and that the hardness of carboloy runs 2000 and above. The tungsten carbide material does not pit or tarnish and is dissolved in acids only with great difficulty. It retains its strength and hardness at elevated temperatures to a remarkable degree. The addition of cobalt to the tungsten carbide is the cause of its increase in strength. E.J.V.

Characteristics of fusible cones and comparison of cones from different sources. ALBERT GRANGER. *La Ceramique*, **30** [476], 493–96 (1927).—An account is given of the work of C. O. Fairchild and M. F. Peters (*Jour. Amer. Ceram. Soc.*, **9** [11], 701–43 (1926)), and of R. F. Geller and E. Pressler (*ibid.*, 744–57, dealing with the characteristics of cones and the differences between cones of different manufacture. A.E.R.W.

Centrifuges and hydro-extraction. B. L. BROADBENT. *Chem. and Ind.*, **47**, 1152 (1928). H.H.S.

Fluid jets and their practical applications. A. L. MELLANBY. *Chem. and Ind.*, **47**, 1153 (1928).—A lecture to the Inst. of Civil Engineers. A number of lantern slides were projected on the screen, showing how the shapes of the nozzles affect terminal velocities. H.H.S.

An effective laboratory drier. R. NEWTON AND W. H. COOK. *Plant. Phys.*, **2**, 359–60 (1927).—A galvanized iron box is lined with asbestos sheeting. The shelving and perforated partition are made of asbestos slate (transite) held in place by light angle-irons and stove-bolts. A rapid air draft is provided by a 9-in. desk fan blowing through a funnel across an electric hot-plate, into a narrow chamber, from which it enters the drying chamber through 5 circular openings, 1.5 in. in diameter, opposite the space above each shelf. The second and third shelves do not run the full width of the drying chamber, but leave an air gap at the left, bridged by light metal pieces. A set of air-holes at the top left is fitted with a damper for controlling the draft. The shelf space is 14 in. square, with 4.5 in. between shelves. With the draft full open and the hot-plate turned to "high" (1000 watts), the temperature of the drying chamber was 61 to 63°. Thermometers are inserted to check the various shelves. To secure the same temperature on all the shelves, it was found necessary to protect the bottom shelf with 2 extra layers of asbestos sheeting, and also to cut down direct radiation by 2 layers of wire gauze over the hot-plate. The narrow chamber to the right is permanently closed in front by the wall of the box. The drying chamber is closed by a glass door, and the hot-plate by a piece of transite containing an opening for the switch. Over both the latter is fitted an outside door of galvanized iron. The drier has been found satisfactory in speeding up the evaporation of aqueous extracts to dryness. (*C.A.*)

Improved "Pyro" optical pyrometer. ANON. *Amer. Machinist*, **67** [18], 713 (1927).—This instrument made by the Pyrometer Instrument Co., New York, is de-

signed for measuring the temperature of small glowing bodies, not inclosed or giving black-body radiation, and of metal being poured. It is used as a telescope, and the object appears in its natural color and magnified 4 diameters. A graduated light filter is turned until the test mark, illumined by a standard lamp, matches the object, and the temperature is then read off on a scale. The weight of the apparatus is 3 lbs., and its range is 1100 to 1650°C (2000 to 3000° F). (*J.I.M.*)

PATENTS

Heat-conductivity apparatus. FRANCIS M. ROWAN. U. S. 1,680,638, Aug. 14, 1928. A test device for ascertaining the heat conductivity of substances, a shell, means for heating the shell, radially disposed heat conducting elements attached to the shell and having different degrees of heat conductivity and all being subjected to and heated uniformly by the heating means, and means associated with the heat conducting elements for indicating the temperature thereof.

Drying ceramic ware and apparatus therefor. THOMAS H. RHOADS. U. S. 1,689,082, Oct. 23, 1928. The process of drying ceramic and like ware comprising the moving of the ware continuously through a single elongated drying chamber, creating a plurality of independent currents of air at different places, respectively, along the drying chamber, heating the air currents to different temperatures, gradually increasing from the inlet end to the discharge end of the drying chamber, circulating the respective heated currents of air transversely of the drying chamber, and causing the adjoining portions of adjacent air currents to blend with each other, whereby the temperature of the drying chamber will uniformly increase from the inlet end to the discharge end thereof.

Kilns, Furnaces, Fuels, and Combustion

Progress in burning coal. A. G. CHRISTIE. *Mech. World*, **84** [2172], 158–60; [2174], 207–209 (1928).—Considerable progress has been made in the burning of coal within the last few years, with the result that coal is now burned with higher efficiency than ever before. Water-cooled walls and radiant-head superheater surface for side walls are becoming standard practice in new installations. There does not appear to be any limit to the temperature of the preheated air when water-cooled walls are used on all sides of the furnace. E.P.R.

Some operating experiences with a pulverized coal system. ANON. *Mech. World*, **84** [2179], 326–28 (1928).—The article is an abstract of a paper by A. L. Pennimen, Jr., and F. W. Quarles, presented at a meeting of the A.I.E.E. E.P.R.

Tunnel kilns. ANON. *Refract. Jour.*, **3** [36], 953–62 (1928).—The paper is an abstract of a Symposium by the American Refractories Institute. E.P.R.

Classification of coal. ANON. Amer. Inst. Min. and Met. Eng., *Tech. Pub.*, No. 156, Class F; *Min. and Met.*, **9** [263], 509 (1928).—Thirteen papers on the classification of coal which were presented at the February (1928) meeting, together with subsequent discussion are abstracted. C. A. Seyler discusses the general aspects of the classification of coal; W. T. Thorn, Jr., from the viewpoint of proximate analysis and calorific value; H. J. Rose, from the ultimate analysis angle; M. R. Campbell, the viewpoint of the geologist; and W. R. Thiessen, that of the peleobotanist. The light which recent discoveries in regard to the classification of coal throw on its classification is set forth by W. Francis, while F. V. Tideswell and R. V. Wheeler discuss pure coal as a basis for classification; F. R. Wadleigh sets forth the commercial classification of coal, followed by the point of view of the railroads, as presented by E. McAuliffe and M. Macfarland. W. H. Fulweiler presents the use of classification of coal as applied to the gas industry and W. H. Blauvelt the standpoint of the by-product coke industry. S. B. Flagg is the advocate of the viewpoint of the steam power user, and F. G. Tryson concludes the symposium with the views of the coal statistician. A discussion follows each paper. F.P.H.

Relative cost and value of fuels. E. A. W. JEFFERIES. *Blast Fur. Steel Plant*, **16** [11], 1446–48 (1928).—Data comparing the relative values of various fuels against their cost show clearly the advantages of producer gas in open-hearth and heating furnace operation. No matter for what purposes producer gas is used, its cost is less than 33% of the cost of oil, and less than 40% of the cost of coke-oven gas for a given amount of heat supplied by a suitably proportional plant of modern producer-gas machines. F.P.H.

Gas producer. ANON. *Ceram. Ind.*, **11** [5], 487–88 (1928).—A new development in gas producers is one made by the Dover Boiler Works, which uses its waste heat to generate its own steam for making gas. The producer is fully water-jacketed and contains very efficient rotary grates. These grates have no perforations through which extremely fine fuel can be washed; and the elimination of water seals makes it practicable to carry blast pressure of several pounds, if necessary, to overcome the resistance of very small fuels. One-half pound of hot gas pressure can be maintained at the burners, without having to cool, boost, or reheat the gas. A saving of a dollar or more per ton of fuel gasified is said to be effected by utilizing the waste heat of the producer to generate the steam used in making its gas. There are no moving parts in the fuel feed. The shell of the producer is made of one-inch steel plate. F.P.H.

New pottery oven. HAROLD J. PLANT. *Pottery Gaz.*, **53** [617], 1761–65 (1928).—Owing to reduced profits and general unsatisfactory conditions of the china trade, it became necessary to find means to reduce sagger costs, to cut down firing expenses and to decrease loss from the ovens. These circumstances led to the invention of the new "C.P.B." oven, by Clark, Plant, and Bennion, of the Tuscan China Works, Longton. Firing time was shortened to 30 or 32 hours by devising an oven similar to that used for pottery firing. It is round, and the inside height less than the width, but instead of having 8 or 9 mouths, only 4 are provided; and instead of having flues in the bottom it has a solid bottom, with the single exception of a flue leading into the chimney. It also has a solid crown, except for the cooling damper, which occupies the position of the ordinary crown damper. The mouths are small and the flame enters the oven through flues about 10 in. square, which lead from the side of each mouth. The central chimney is built from the floor of the oven to within a few inches of the crown and is perforated with small holes; the flames, instead of going up from the "bags" and out the top, as in the case of the ordinary updraft oven, or up and down, as in the ordinary downdraft oven, pass between the saggers, through the perforations in the central stack, and then to the chimney stack. The bungs are so arranged and the saggers so placed that the flame practically circulates round the sagger, creating an almost equal temperature in any and every part of the oven. In the course of firing trials a number of important facts were discovered. In glost firing it was found that an entirely different temperature was necessary to fire up a glaze successfully in the old oven as compared with the new. In the first case, taking 32 hours to fire, 1100°C were required, whereas, when the glaze was fired in the new oven it was fired up perfectly at 1080°C in 16 hours. The old method of firing brought about a volatilization of the fusing materials whereas under the new method of firing the fluxes were allowed to do their work. In the case of china biscuit the time of firing has been reduced to less than one-half the original period occupied. The new oven is easy to control and as near fool-proof as possible and is oxidizing, the amount of smoke being practically nil. A feature of the new oven is the equalization of the temperature throughout, which means that the oven should be fired with either an assortment of goods, such as plates, saucers, cups, etc., or fired with all hollow ware if necessity arose. Repair costs are practically negligible. Notwithstanding the shortening in the firing period, the resultant products from the new oven are free from the majority of the previous faults. The wearing qualities, appearance,

brilliance of the glaze, and general appeal of the ware fired under the new conditions are much greater than under the old. E.J.V.

Hydraulic theory of furnace gas movement. ANON. *Pottery Gaz.*, **53** [617], 1785 (1928).—This theory regards the movement of a flame as that of a light fluid within a heavy one. To deal properly with the problems of the action of flames in the interior of furnaces and of hot air in driers it is necessary to know: (1) the mechanism of the movement of warm air; (2) the mechanism of the transmission of heat by convection; (3) the dependence of the numerical value of the transmission of heat on the size, position, form, and nature of the surface. Thus are obtained the data necessary for the calculation and designing of thermo-technical structures. The first experiments made by State laboratories at Leningrad are described. These are not sufficiently numerous for definite conclusions to be drawn; but some practical applications of the theories evolved have been attempted. A Fougeront tunnel kiln has been remodeled at a porcelain and earthenware manufactory near Tver. The length of the kiln is 65 meters. According to the statement of Skwortzoff, the Fougeront Co., when constructing that tunnel in 1910, had warranted an output of 24 tipple-cars per 24 hours. The actual output of the tunnel, fed on best firewood fuel, was 55 cars in 24 hours. The rate of consumption of equivalent fuel with a heating value of 7000 calories per kg. was 170 kg. per car-load, or 170 kg. per 250 kg. of earthenware. The reconstructed tunnel was made with semi-producer gas firing and with internal circulation of furnace gases. As regards fuel, firewood with 35% moisture content was used. The output was increased to 72 cars in 24 hours. The rate of fuel consumption (equivalent fuel) is 88 kg. per car-load, or 88 kg. per 250 kg. of earthenware. This means a 30% increase in the output and a 48% decrease in fuel consumption. The difference in top and bottom temperatures of the car-load is hardly detected by a thermocouple. Such a low difference in top and bottom temperatures greatly assists the production of high quality wares. It is quite obvious that various special devices and contrivances used in numerous designs of tunnel kilns in order to obtain a uniform rate of heating are altogether superfluous. The hydraulic theory has solved the problem in a very simple way. The CO_2 content in furnace gases varies from 14.5 to 17%, which may be considered quite satisfactory for a tunnel kiln. E.J.V.

Electrical firing of enamels on porcelain. Y. MATSUNAGA. *Pottery Gaz.*, **53** [617], 1785–86 (1928).—The process of firing color in an electric kiln is as follows: Plain porcelain ware, after being decorated, is thoroughly dried and arranged neatly on shelves in the kiln. When the packing is completed, the cover is closed and the ventilating ducts are opened at the top and bottom of the kiln. During the first 3 or 4 hours, only $^1/_3$ of the heating power is applied to the kiln. During this "aburi," or "slow baking," the combustion of the glue and varnish contained in the enamel compounds takes place, and the organic gases so liberated are driven out of the kiln. All ventilating ducts being closed, the full heating power is applied for 2 or 3 hours. As soon as the required temperature is reached, the heating current is shut off. The temperature is judged by the color of the contents, which is seen through the spy-hole. Sometimes, instead of cutting off the current abruptly, the application of heat is continued at a reduced rate for about 30 minutes before being cut off completely. After the heating power is switched off, the kiln is allowed to stand for about 2 hours to cool off before the ware is taken out. In cooling, an electric fan is often used to hasten the process. The size of ware fired may be as large as 48 cm. in diameter, as in the case of a plate, or 60 cm. in height, as in the case of a vase. At the other extreme, there may be a pepper-shaker 3 cm. in height, or even smaller. The total weight of the ware differs more or less according to the size and shape of the kiln. The temperature required varies with the color chosen; 750°C is required for cassius purple, while 500°C may be sufficient

for gold or coral luster. The melting point of muffle coloring materials prepared at different places varies slightly, and the temperatures mentioned are not to be taken as exact in all cases. As soon as adhesion between the glazing material and the coloring matter is complete, the application of heat should be discontinued immediately. The time required to complete the coloring process depends on the thickness of ware, the kind of potter's clay, and the variety of muffle coloring. The process of slow baking also ranges from 2 to 4 hours, varying according to the weight and arrangement of the ware, which cannot be uniform in all cases. Then 2 or 3 hours' full heat application follows, until the required temperature is reached. At this instant, the proper color and glaze of the ware become clearly apparent. The power consumption for the muffle color process cannot be given definitely, as it varies with the shape and quality of ware, as well as with the variety of color. A 50-kw. kiln usually takes 200 to 250 kw.-hr. for one complete operation. E.J.V.

Rational firing of refractories. ALBERT HIRT. *La Ceramique*, **31** [480], 45–48 (1928).—Conditions which obtain in modern furnaces impose severe requirements on refractories. Ability to carry loads at high temperatures is especially important. Refractories to meet these requirements can only be obtained by using kilns which insure regularity, uniformity, and completeness of firing. H. points out the importance of these three factors. Many manufacturers of refractories do not fire their products completely. Two types of kiln will enable refractories to be fired in the correct manner, *viz.*, forced draft continuous kilns (gallery), and direct-fired forced draft tunnel kilns. Operation under pressure prevents the entrance of parasitic air. It is an established principle in metallurgy but new in ceramics. It has, however, already proved its worth. H. gives the advantages of operation under forced draft in detail and the data given in the following table illustrate his remarks:

Comparison of Mean Consumptions of Hirt Furnaces, Induced and Forced Draft, Heated with Coal and Producer Gas. (Consumption of Coal in Kg. per T. of Fired Products)

Firing temperature, °C (oxidizing)	Periodic kilns, average minimum consumption	Induced draft continuous		Forced draft		
				Continuous		Tunnel
		coal	gas	coal	gas	gas
800– 900	120	55	60	50	56	50
900–1000	160	70	75	64	68	60
1000–1100	200	90	96	86	90	83
1100–1200	240	115	122	105	110	97
1200–1300	280	125	135	115	120	110

NOTE: Firing with gas consumes more coal than firing directly. This is largely compensated for by the ease of regulation, economy in labor, and better quality of product.

Continuous and tunnel kilns can be used for firing dinas and silica bricks, despite the fact that periodic kilns are used in Germany. It is a matter of making the tunnels long enough to get the slow rate of cooling. Forced draft is especially advantageous in this case. A.E.R.W.

Water-smoking. ANON. *Brit. Clayworker*, **37** [438], 265 (1928).—Notwithstanding all that has been written on the subject, many firemen still experience great difficulty in water-smoking brick in a continuous kiln. The chief fault is that proper progress of the kiln fire can never be realized unless the bricks are dry and warm before they are taken into the round of the kiln. The first essential is to dry and warm the freshly set goods within the time allotted for the purpose. If considered essential to set wet bricks in a continuous kiln, sufficient additional chambers must be provided to allow for the extra drying needed. It is impossible for a kiln fire to travel at the proper

speed if it has only 14 or 16 chambers and is filled with goods which have not been previously dried. The best results are obtained when the goods are so nearly dry that only 2 chambers are needed to dry and warm them to about 120°C, and when the chimney is large enough to create the necessary draft. With these 3 essentials, (1) dry goods, (2) sufficient number of chambers, and (3) powerful chimney, it is a comparatively easy matter to have a rapid fire-travel. Most kiln chimneys work best when the gases at the base have a temperature of 100 to 150°C; at a lower temperature the draft is sluggish and the kiln works slowly. To increase the temperature at the chimney base, 2 methods are available, but in practice only the one can be used: (*a*) gases may be drawn from the last chamber to the main flue at a higher temperature than before, only one damper being used, or (*b*) 2, 3, or even 4 dampers may be open to the main flue. The first method is applicable only when the goods are not sensitive to a sudden rise in temperature. R.A.H.

The Wollaston producer boiler. ANON. *Colliery Eng.*, **5**, 158–60 (1928).—Illustrated particulars are given of the Wollaston producer boiler for the utilization of low-grade fuels. Producer-gas is generated in a producer and is burnt direct in vertical or horizontal boilers without loss of the sensible heat of the gas. One of the advantages of the producer furnace is its ability to burn inferior fuels containing a high percentage of ash and moisture. Particulars of tests results are also included. (*J.I.S.I.*)

BOOK

Annual Report of Fuel Research Board. C. H. LANDER. 70 pp. H. M. Stationery Office, London, 1928. Price 1*s* 3*d*.—The year was one of steady recovery from the effects of the long coal stoppage in England. The main functions of the Board, the national survey of coal resources, and the large-scale work at the research station on carbonization, hydrogenation, etc., showed satisfactory progress. Reviewed in *Chem. and Ind.*, **47**, 1055–56 (1928). H.H.S.

PATENTS

Rotary kiln and furnace. JOHN HENRY BENTLEY. U. S. 1,690,048, Oct. 30, 1928. In a rotary kiln or furnace having a preliminary cooling chamber between the sintering zone and a central discharge orifice the combination with lifting ducts at the end of the cooling chamber having scoop-like openings at its circumference, of a delivery cone provided by a conical or inclined guide closing their inner ends to the interior of the kiln and opening them to the exterior.

Sintering machine. BETHUNE G. KLUGH. U. S. 1,690,231, Nov. 6, 1928. In a sintering machine, an endless track, a plurality of pallets traveling about the track, magnetic means for controlling the travel of the pallets around the track to retain the pallets in contacting relation along a particular portion of the track, and means for varying the intensity of action of the magnetic means.

Furnace door and pusher interlock. FRANK T. COPE. U. S. 1,690,272, Nov. 6, 1928. In combination with a furnace, a door and a pusher for moving material into the furnace when the door is in the opened position, a motor for operating the door, a switch controlling the door motor, a motor for operating the pusher, a switch controlling the pusher motor, an interlock switch in parallel with the pusher motor switch, a sliding bar operated by the door motor, switches engaged by the sliding bar to stop the door motor when the door is in the fully opened or fully closed position, the sliding bar engaging the interlock switch to close it only when the door is in the fully opened position.

Electric furnace. FRANK T. COPE. U. S. 1,690,273, Nov. 6, 1928. An electric furnace including a refractory roof, spaced independently detachable blocks having ledges upon the under side of the roof supported independently of the roof and rigid resistor grids supported at their end portions only upon the ledges.

Kilns. A. L. GELDENS. Brit. 295,867, Oct. 17, 1928. *Multiple chamber kilns:*

In a continuous kiln having an endless series of compartments each with a combustion chamber or fire-place formed by a transverse wall spaced from the partition wall between adjacent chambers, a substantially horizontal baffle is provided at the upper end of the wall to direct the heating gases along the roof of the chamber before they pass downward into the charge. The baffle is preferably formed with combustion product passages. The gases from a preceding chamber pass to the combustion space through trace holes and dampered apertures and in the early stages of firing may pass direct to the goods chamber through tubes subsequently closed by the ashes from the fire. *Firebars, and grates:* Fuel is fed to the combustion space between the walls through openings in the roof, and is distributed by refractory bars to an upper grate through which it passes to a lower grate. The bars of the grates are so spaced that the total area of the passages in the upper grate is greater than that on the lower. In a modification, there are three grates, the middle one being stepped. The grate bars are made of refractory material and are of rectangular cross-section, parts being cut away to form the air passages. The cut-away portions may extend the whole distance between the walls or solid portions may be left to provide an imperforate strip extending along the grate. The bars may be grooved on their top, bottom, and side faces, and they may be formed with longitudinal passages connecting adjacent compartments.

Pottery kilns. T. G. MCDOUGAL. Brit. 295,955, Oct. 17, 1928. In a tunnel kiln for firing ceramic ware such as spark plug porcelains, insulators, etc., the ware is carried by a conveyer mechanism located mainly outside the heating chamber and having article supporting ends which project into the heating chamber through a narrow slot, the ends being no wider than the slot, so that the parts of the articles adjacent thereto are not shielded from heat radiated from the walls.

Geology

Mineral names. ARTHUR S. EAKLE. *Amer. Mineral.*, **13** [11], 533–36 (1928).—E. discusses the origin of names of minerals and concludes that the ideal name for a mineral should possess the following qualifications: (*a*) it should be familiar to mineralogists; (*b*) it should have a meaning of value to all mineralogists; (*c*) it should be an honor to, and enhance the value of, the science of mineralogy; (*d*) it should be applicable to the species independent of its origin, properties, or localities; (*e*) it should come from a source abundantly able to supply names for the future describer of new mineral species. F.P.H.

Olivine from Hawaiian Islands; pure forsterite. M. AUROUSSEAU AND H. E. MERWIN. *Amer. Mineral.*, **13** [11], 559–64 (1928).—Optical data on pure forsterite are given. F.P.H.

Classification of the calcite group. G. BILIBINE. *Amer. Mineral.*, **13** [11], 569 (1928); *Men. Soc. Russ. Mineral., II*, **56**, 3–36 (1927).—The isomorphous mixtures are classified as follows: *Binary mixtures:* Pistomesite (Mg, Fe)CO_3, Oligonite (Fe, Mn) CO_3, Roepperite (Ca, Mn)CO_3, Dolomite Ca, Mg $(CO_3)_2$, Monheimite (Zn, Fe)CO_3, Baritocalcite Ca $Ba(CO_3)_2$. *Ternary mixtures:* Ankerite Ca (Mg, Fe) $(CO_3)_2$, Cobaltssmithsonite (Zn, CO, Mg)CO_3. *Quaternary mixtures:* Kutnohorrite (Ca, Mg, Fe, Mn)-CO_3. The limiting values are: for binary mixtures not less than 25% of the second constituent; for ternary mixtures not less than 17% of the third constituent. F.P.H.

Hydrothorite. EDWARD S. SIMPSON. *Jour. Roy. Soc. W. Australia*, **13**, 37–39; *Amer. Mineral.*, **13** [11], 570 (1928).—Hydrothorite is a hydrated thorium silicate ($ThSiO_4 \cdot 4H_2O$). Analysis (containing a small quantity of a carbonate, phosphate, and probably a second silicate): SiO_2 15.77, ThO_2 57.79, Ce_2O_3 0.25, Y_2O_3 0.73, UO_3 2.98, Mn_2O_3 tr., Al_2O_3 0.88, PbO 1.25, CaO 1.65, MgO 0.60, H_2O 15.18, CO_2 1.50, P_2O_5 1.33;

total 99.90. It is attacked by warm moderately concentrated acids with the separation of silica. Physical and optical properties: color pale pinkish buff to cartridge buff (Ridgeway) when dry, pale orange yellow when wet. It is opaque, transparent under the microscope, isotropic; $n = 1.638$; strongly radio-active, H = 1.2, and falls into small flakes in water. Occurrence: Found in the tantalite bearing pegmatite at Wodgina, associated with mackintoshite, thorogummite, pilbarite, albite, quartz, spessarite, manganotantalite, and weathered lithiophilite. It is an alteration product of mackintoshite. F.P.H.

Dumortierite. O. G. GRAWE, J. C. JONES, J. A. CARPENTER, AND W. S. PALMER. MacKay School of Mines (Univ. of Nevada) *Bull.*, No. 2 (1928); *Amer. Mineral.*, **13** [10], 532 (1928).—The mineralogy of dumortierite including the bibliography (consisting of 53 titles) was compiled by G.; the geology of the deposits in Humboldt Queens Canyon, Nev., its origin and petrography were written by J.; the mining of dumortierite is described by C., while P. records the dressing tests. While dumortierite has been reported from seven states, the Humboldt Queen deposit is the only known commercial occurrence. Here it occurs in lenticular masses and in quartz veins, the former originating through the replacement of preëxisting lenses of andalusite formed in an earlier stage in the metamorphism of the rocks. The use of this mineral together with that of andalusite, in the manufacture of spark plug porcelain and special chemical porcelain ware is briefly described. F.P.H.

Quantitative studies in geology. ANON. *Eng. Min. Jour.*, **125** [14], 537 (1928).—Examples of cases requiring quantitative data are: (1) solution of limestone and dolomite, (2) weathering of feldspars, olivine, hornblende, enstatite, etc., (3) viscosity of lavas, (4) falls in rocks, (5) stream measurements. A.J.M.

Analcite-rich rock from Deccan traps of India. N. L. BOWEN. *Jour. Wash. Acad. Sci.*, **17** [3], 57 (1927).—It appears that the rock is a nephelite basalt which has suffered analcitization, but the possibility that it is an analcite basalt and the analcite dominantly primary cannot be excluded. A.J.M.

Natural resources of Wales: fire clay. F. J. NORTH. *Brit. Clayworker*, **37** [438], 269–70 (1928).—In Wales all fire clays are obtained from coal bearing strata or coal measures. In the South Wales coal field practically every coal seam has beneath it a layer of unstratified fire clay often crowded with fossil roots but never containing many impressions of leaves like those so often found in shales immediately or a little above coal seams. The fireclay beds vary in thickness from a few inches to 3 or 4 ft., and like coal often have to be obtained by mining. Fire clays vary greatly in appearance. Some are hard and sandy and others soft and claylike. In color they range from almost white to gray or nearly black, the dark tint being due to the presence of finely divided carbonaceous matter representing disintegrated plant tissues; some of the Flintshire fire clays are purplish red. When heated in contact with lime or metallic oxides (as is often the case with a furnace lining) the fire clay tends to unite with those substances forming new compounds that have a lower melting point than fire clay alone; this, together with the friction resulting from the movements of the contents of the furnace, eventually spoils the bricks and necessitates their replacement. R.A.H.

State of San Luis Potosi and its mineral resources. M. PEROGORDO Y LASSO. *Rev. Mex. de Ing. y Arch.*, **6** [10], 487–537 (1928). T.W.G.

Calcite and aragonite. CHARLES HAMILTON SAYLOR. *Jour. Phys. Chem.*, **32** [10], 1441–60 (1928).—All crystalline substances absorb, from their mother liquor, ions of electrolytes and molecules of solvent and dissolved nonelectrolytes. Adsorption on crystal face retards growth normal to surface and favors enlargement of the form. When a cation is preferentially absorbed upon one face of a crystal, anions are preferentially adsorbed upon the other principal crystal faces. The nonelectrolytes, urea,

glycocoll, and mercuric chloride are adsorbed upon the same crystal faces as readily adsorbed anions. Alcohol tends to prevent adsorption of anions. Adsorption of anions upon the unstable octahedron faces of the alkali halides, the cube faces of the alums, and upon the end forms of sodium nitrate favor their enlargement. Adsorption of cations upon the cube faces of barium nitrate and upon the side forms of sodium nitrate increases the size of these faces. Sufficiently strong preferential adsorption upon an allotropic modification will spoil each crystal nucleus as a center for crystal growth and tend to obstruct the modification. This allows an unstable allotropic modification to be stabilized temporarily. Aragonite and μ calcium carbonate are enabled to exist because bicarbonate ion, acetate ion, urea, the high temperature form of water, and organic material in the shells of mollusks are preferentially adsorbed on calcite and prevent growth of calcite crystals. L.A.P.

Rationalization in the tin industry. ANON. *Chem. and Ind.*, **47**, 1037 (1928).—About 40% of the world output of tin comes from the British Empire, but only the Nigerian field, which produces 8%, is well organized. The Malayan groups have now amalgamated with the Nigerian for more efficient production. Of the remaining world output, South America and Dutch East Indies produce 25% each. H.H.S.

Feldspar production in 1927. DOMINION BUREAU OF STATISTICS. *Clay Prod. News*, **1** [8], 10 (1928).—Feldspar, both in the U.S. and in Canada, declined in production in 1927 as against the previous year. The U.S. decline was 4% in quantity and 11% in price. Canadian production was 29,849 T. in 1927 (35,951 in 1926) valued at $259,151 ($310,238), the price remaining fairly steady. Capital employed by the 29 Canadian firms was $322,978; wages of 234 employees were $151,553; cost of fuel for the year $10,232. H.H.S.

Nomenclature of bauxite. FRITZ KERNER. *Montan. Rundschau*, **20**, 257–59 (1928).—The bauxite minerals may be divided into the following groups according to mineralogical and chemical composition: only $Al_2O_3 \cdot H_2O$, diasporite; more $Al_2O_3 \cdot H_2O$ than $Al_2O_3 \cdot 3H_2O$, "unterbauxite" or "miobauxite;" equal amounts of $Al_2O_3 \cdot H_2O$ and $Al_2O_3 \cdot 3H_2O$, bauxite; more $Al_2O_3 \cdot 3H_2O$ than $Al_2O_3 \cdot H_2O$, "über-bauxite" or "pliobauxite;" only $Al_2O_3 \cdot 3H_2O$, gibbsite. Aluminous laterite and siliceous bauxite are synonymous. (*C.A.*)

BOOKS

Diatomaceous Earth. IMPERIAL INSTITUTE. Published by H. M. Stationery Office. Price 1*s* net. Reviewed in *Amer. Mineral.*, **13** [11], 566 (1928).—This is one of a series of reports in the mineral industry of the British Empire and other countries. The report on diatomaceous earth covers the general physical properties of the material, uses, preparation for market, prices, production, and distribution not only in the British Empire but in 24 foreign countries as well. F.P.H.

Clays: Their Occurrence, Properties, and Uses. HEINRICK RIES. *Econ. Geol.*, **23** [1], 112 (1928); for review see *Ceram. Abs.*, **6** [10], 485 (1927). E.P.R.

Chemistry and Physics

Thermodynamic properties of oxygen and nitrogen. R. W. MILLAR AND J. D. SULLIVAN. Bur. Mines., *Tech. Paper*, No. 424 (1928).—The production of liquid air or liquid oxygen from gaseous air obviously requires for its economic control a knowledge, as exact and complete as possible, of the properties of both liquid nitrogen and oxygen. The present report represents a collection of (in a useful form) such thermodynamic data concerning these two substances as now exist. Heat capacity, vapor pressure, heats of vaporization, calculation of heat content, and isothermal data are included. Two Mollier charts covering properties of oxygen and nitrogen are attached. R.A.H.

Production of high-alumina slags in the blast furnace. T. L. JOSEPH, S. P. KINNEY, AND C. E. WOOD. Bur. Mines, *Tech. Paper*, No. 425 (1928).—In the operation of a blast furnace the earthy materials or gangue of the charge are fused together to form slag. In connection with this problem it was found that in the absence of experimental evidence that a blast furnace can be operated on a burden of iron ore, bauxite, limestone, and scrap, melting point determinations were an invaluable guide in predicting the behavior of high-alumina slags. Melting point determinations showed that a furnace could be operated on slags containing 47 to 48% alumina, 41 to 42% calcium oxide, 4 to 5% silica, and small percentages of titania, magnesia, and sulphur. Slags containing calcium oxide and alumina usually have the lowest melting points when the percentage of the calcium oxide exceeds the percentage of alumina. Viscosity determinations in the ternary system calcium oxide–alumina–silica show that the ternary eutectic composed of 49.5% calcium oxide, 43.7% alumina, and 6.8% silica has a relatively low viscosity and that only a small change in viscosity takes place with changes in temperature above the melting point. During a 2-week test experimental furnace slags were produced covering the following range of composition: 6 to 33% silica, 35 to 52% calcium oxide, 18 to 53% alumina, about 2% titania, 1% iron oxide, and 0.5% sulphur. No difficulty was encountered in operating the furnace on slag of this wide range in composition. The report gives a description of the operations, kinds and percentages of raw materials used, melting point determinations, and temperature-viscosity relations. R.A.H.

International temperature scale. GEORGE K. BURGESS. Bur. Stand., *Jour. Research*, **1** [4], 635–40 (1928).—In 1911, the directors of the national laboratories of Germany, Great Britian, and the U. S. agreed to undertake the unification of the temperature scales in use in their respective countries. The experience of the Bureau of Standards as of the National Physical Laboratory and of the Reichsanstalt, has for many years past indicated the necessity, for industrial purposes, of international agreement on a scale of temperatures ranging from that of liquid oxygen to that of luminous incandescent bodies. As a result of discussion extending over a considerable period, agreement has been reached by the 3 laboratories. This proposal does not purport to replace the absolute temperature scale which is recommended by the international conference on weights and measures. The article describes in some detail the definition of the international temperature scale. The basic fixed points and the numerical values assigned to them for the pressure of one standard atmosphere are given, together with formulas which represent the temperature (t_p) as a function of vapor pressure (p) over the range 680 to 780 mm. of mercury. The recommended experimental procedure is given for determining the basic fixed points for oxygen, ice, steam, sulphur, silver, and gold. A description of the standard platinum resistance thermometer and standard thermocouple is included. A number of secondary points are also mentioned which may be used in the calibration of secondary temperature measuring instruments. R.A.H.

Thermal expansion of magnesium and some of its alloys. PETER HIDNERT AND W. T. SWEENEY. Bur. Stand., *Jour. Research*, **1** [5], 771–92 (1928).—Data are given on the linear thermal expansion of 6 samples of cast and extruded magnesium and 11 samples of cast and extruded magnesium alloys over various temperature ranges between −183 and +500 °C and most of the alloys between room temperature and 300 °C. Three types of apparatus were used and a summary of available data by previous observers on the thermal expansion of magnesium and some magnesium alloys is given. The following average equation represents the expansion of magnesium between 20 and 500 °C: $L_t = L_o [1 + (24.8t + 0.00961t_2)10^{-6}]$. The coefficients of expansion of extruded magnesium and the alloys investigated are slightly less than those for the

cast materials. Average expansion data and data from previous observers are compared. Relations between chemical composition and coefficients of expansion are shown. The addition of 0 to 10% aluminum to magnesium causes practically no change in the coefficient of expansion. Small additions of manganese (0.9 and 0.3%) to magnesium and magnesium-aluminum alloys cause slight changes in the coefficient of expansion. The table in the summary gives a comparison of the average coefficients of expansion of the materials investigated. R.A.H.

Crystal structure of potassium. E. POSNJAK. *Jour. Phys. Chem.*, **32** [3], 354–59 (1928).—P.'s results differ from statements of previous investigators, in that he found that normal diffraction effects are obtained for K at room temperature by powder method. He assigns as reason for obtaining in earlier experiments only a general scattering and no definite diffraction, the formation of films on the samples of K by moisture, by oxidation, or by the reaction of the K with the glass. Improved method of preparing samples of potassium are described. Data indicate that K crystallizes in the body-centered cubic lattice. The length of the unit cube containing two atoms of K is 5.333 ± 0.005 Å. The calculated density is 0.851. Lengths of edges of unit cubes of Na and Li were redetermined and agree with values determined in earlier investigations, being 4.30 Å and 3.51 Å, respectively. L.A.P.

Heats of adsorption of certain vapors on charcoal at 25°C. J. N. PEARCE AND LLOYD MCKINLEY. *Jour. Phys. Chem.*, **32** [3], 360–400 (1928).—The decrease in the adsorption of an acid dye, Orange II, by Fe, Al, and Cr gels (mordants) in presence of phosphates is not due to any effect of the phosphate adicol upon dye or solution. It is due to phosphate forming a relatively insoluble compound with the gels, hence not providing any metal ions to react with dye and form the metal-dye compound, which is the cause of adsorption. If X represents dye radical and if Fe gel with HCl solution of dye is used, reaction proceeds as follows:

$$NaX + HCl \rightleftharpoons NaCl + HX \quad (1)$$
$$3HCl + Fe(OH)_3 \rightleftharpoons FeCl_3 + 3H_2O \quad (2)$$
$$FeCl_3 + 3NaX \rightleftharpoons FeX_3 + 3NaCl \quad (3)$$
$$3HX + Fe(OH)_3 \rightleftharpoons FeX_3 + 3H_2O \quad (4)$$
$$3NaX + Fe(OH)_3 \rightleftharpoons FeX_3 + 3NaOH \quad (5)$$

Postulate that most adsorption is due to reaction (3). Some little is due to (4) and (5). H_2SO_4 acts very similar to HCl in these reactions. If phosphoric acid is used it acts in (1) similar to HCl. In (2) it forms an insoluble iron phosphate, thus preventing reaction (3). Hence unless solution is made sufficiently acid to dissolve the iron phosphate no adsorption results. Al and Cr gels act similar to Fe. L.A.P.

Ammonous nitrides. F. W. BERGSTROM. *Jour. Phys. Chem.*, **32** [3], 433–40 (1928).—The theory that cobaltous amide is an ammonous cobaltous amide serves as an explanation of anomalous properties of the former. The hypothetical formula is $CoN_2 + xNH_3$. It was not found possible to precipitate an Al amide, imide, or nitride of definite composition from a liquid ammonia solution of Na or K ammono aluminate. Since the precipitated substances, under comparable conditions, contain from 40.7 to 55.6% Al and 52.0% N with very little alkali metal or Br as impurity, they may be regarded as ammonous aluminum nitrides, $AlN + xNH_2$. The small amount of NH_3 frequently retained by many nitrides prepared in liquid NH_3 is perhaps bound in the same manner as the NH_3 in xNH_3 or $AlN + xNH_3$. Prepared stannous imide = $SnNH$, Sn_2N_2. The former may be a definite compound and not an ammonous stannous nitride. L.A.P.

Synthesis over Ni and Cu catalysts. FRANCES E. SMITH. *Jour. Phys. Chem.*, **32** [5], 719–33 (1928).—Catalysts (Cu, Ni, two mixtures of Ni and Cu, and mixture of

Cu and Al_2O_3) were prepared by reduction of the precipitated hydroxides and studied, as was Cu prepared by reduction of fused oxide. These catalysts were used in water synthesis at 75 to 180°C and maintained an O_2 concentration of 2.4%. In order of decreasing catalytic efficiencies, the catalysts were: Cu–Al_2O_3, Cu from fused oxide, Ni, Ni–Cu, Cu–Ni, and Cu from precipitated hydroxide. Most effective catalysts were found to be those which formed the greatest amount of oxide during the catalytic reaction and which changed the least in physical structure on reduction and later heat treatment. With the exception of Ni, heating catalysts to 444°C decreased their efficiencies. The Ni transmission point is about 360° at which its physical properties change. These data agree with H. S. Taylor's theory of "catalyst surface."

L.A.P.

Adhesives and adhesion. JAMES W. MCBAIN AND W. BELL LEE. *Jour. Phys. Chem.*, **32** [8], 1178–84 (1928).—Pure chemical compounds of different types exhibit very different adhesive power when used for joining polished metal surfaces, the strength varying in definite relation to chemical constitution. The highest adhesive power was 1 T. per sq. in. There is a noticeable increase of strength when the film of adhesive is exceedingly thin; explained by assuming the existence of chains of oriented molecules extending from the surface well into the liquid or solidified adhesive. Intimate relation between study of adhesion and lubrication is well exemplified by compounds studied. Adhesive power goes parallel with static friction. Use of pure chemical compounds greatly simplifies the scientific study of wooden joints. Pure coumarin affords a good example of a strong joint in which both specific adhesion and mechanical embedding are operative.

L.A.P.

Influence of pressure on high-low inversion of quartz. R. E. GIBSON. *Jour. Phys. Chem.*, **32** [8], 1197–1210 (1928).—When quartz is subjected to a uniform hydrostatic pressure of P megabaryes, the temperature of its high-low inversion is raised according to the equation $T = -0.3 + 2.1 \times 10^{-3} P + 8.6 \times 10^{-7} P^2$. This equation expresses the results of direct experimental observations made between 0 and 3000 megabaryes. From the initial pressure coefficient and the instantaneous volume change during the transformation, it follows that the latent heat of inversion is 3.1 cal. per g. The high-low inversion of a quartz crystal at one atmosphere pressure is a change of phase, generally accompanied by superheating and supercooling. At 572.3 ± 0.2°C, however, low quartz is apparently converted reversibly to high quartz and but for experimental difficulties the two phases could be had together in equilibrium at this temperature. Prior to passing to high quartz, a block of low quartz superheats to an extent such that during inversion its temperature never falls to equilibrium value. Therefore reaction is adiabatic and apparent heat capacity of low quartz, at or near 573°C, can be calculated. This is 4 ± 1 cal. per g. per degree. Nothing was found relative to changes in physical properties of quartz between 0 and 570°.

L.A.P.

Permeability testing apparatus. ANON. *Eng. Min. Jour.*, **125** [15], 567 (1928).—The apparatus was devised to measure the rate of flow of water through columns of water-bearing materials. The method is to allow inflow of water at the bottom of a column of the material of known height and to allow outflow at the top. The difference in head of water at the bottom and the top is regulated by an adjustable supply tank and is indicated by two pressure gages. Observations are made on the rate of discharge and the temperature of the water.

A.J.M.

Theory of sampling. T. T. READ. *Eng. Min. Jour.*, **125** [15], 574 (1928).—R. discusses sampling in great detail from the viewpoint of statistical mathematics.

A.J.M.

Determining composition by specific gravity. L. O. HOWARD. *Eng. Min. Jour.*, **125** [15], 617 (1928).—This method may be useful in determining the compositions

where mixtures of two solid substances are involved. The following formulas are developed mathematically:

$$\text{Per cent by weight of lighter material} = \frac{S_A(S_B-S)}{S(S_B-S_A)}$$

$$\text{Per cent by weight of heavier material} = \frac{S_B(S-S_A)}{S(S_B-S_A)}$$

where S_A is the specific gravity of the lighter material, S_B is the specific gravity of the heavier material, and S is the specific gravity of the mixture. Percentages by volume can be expressed by the formulas $\frac{S_B-S}{S_B-S_A}$ and $\frac{S-S_A}{S_B-S_A}$ for solids of lesser and greater gravity, respectively. A.J.M.

Mechanical properties of moist granular solids. P. G. NUTTING. *Jour. Wash. Acad. Sci.*, **17** [8], 185 (1927).—Silica, alumina, most silicates, and many metals adsorb a film of water from 50 to 100 or more molecules deep under ordinary atmospheric conditions and part with it with great reluctance when desiccated or heated. This film represents 20 to 25% by weight in finely divided or porous materials such as bentonite and silica gel and about 1 mg. per gram even in ordinary sand. The adsorptive force between the silica and the water in contact with it is about 17,000 atmospheres and decreases almost linearly with the depth of the film. The depth of the adsorbed film represents equilibrium between external fluid or vapor pressure and internal adsorption pressure. The cohesional force increases with the amount of water present up to a maximum and then falls off to zero with complete wetting. The cohesional force per unit area acting between individual particles varies inversely as the diameter of the particles. The aggregate cohesional force in a unit cube (pressure gradient) varies inversely as the square of the linear dimensions of the component particles. A drying silt or clay is subjected to internal cohesive pressure of 15,000 atmospheres. Powdered quartz under 0.2 micron in diameter, when suspended in water, exhibits the peculiar stratification so familiar in the case of bentonite in suspension. The finest quartz particles never settle but in a week or two hydrate to silicic acid and go into dialyzable solution. An aggregate of fine and coarse particles together, when moist, takes on the properties of the finer particles alone since each large particle has high cohesion and rigidity within itself. The fine particles act simply as cementing material. The proportion of fines needs to be only very small since the cementing function is limited to the very small volume in the immediate neighborhood of points of contact between larger particles. The densities of fine particles, determined by the pycnometer method are apparently higher when water is used instead of a much less strongly adsorbed liquid such as turpentine because the cohesion pressure is so great that the water may be compressed. Condensed adsorbed films on fine siliceous particles immersed in water show a slight surface tension toward the adjacent uncondensed water tending to draw the particles together. A.J.M.

Character of the 573° inversion of quartz. R. B. SOSMAN. *Jour. Wash. Acad. Sci.*, **17** [13], 344 (1927).—Some of the questions to be answered by experimental study are: (1) Is there a real discontinuity in properties at 573°C or can the change be represented simply by two continuous curves which intersect? The data favor the existence of a discontinuity. (2) Is there a temperature-hysteresis in the inversion? The data on this point are less certain, but such hysteresis (independent of time) seems to be present. (3) Is the change in properties simultaneous for all properties? There is evidence that the optical change precedes the volumetric. (4) Is there ever an equilibrium between the high-temperature and low-temperature phases? The change appears to be unlike a melting point, and resembles rather a mechanical or electrical system

which passes through a region of instability. S.'s abstract alone is published under the reference cited. A.J.M.

Relation of chalcedony to quartz. W. P. WHITE. *Jour. Wash. Acad. Sci.*, **17** [13], 344 (1927).—The exact nature of chalcedony has been in doubt for some time. Microscopic evidence has indicated that it is a rather peculiar form of quartz. Fenner showed conclusively that it failed to manifest the characteristic quartz inversion when tried with apparatus which had given this inversion with normal quartz. Later, Washburn reported that chalcedony gives the X-ray pattern of quartz, and Sosman, from a study of Fenner's original data, detected some evidence of the quartz inversion. An examination with duplicate calorimeters especially arranged for this test gave unmistakable signs of the quartz inversion, though in a strikingly different form from that manifested in the same apparatus by quartz. The inversion in chalcedony is completed at practically the same temperature as that in quartz within the precision of the experiment, which is probably better than a degree, but the inversion in chalcedony undoubtedly begins at a lower temperature. Whether the total amount of heat involved is as great as with quartz cannot be told from the results so far obtained. Only W.'s abstract is published under the reference cited. A.J.M.

The 573° inversion of quartz. F. BATES AND F. P. PHELPS. *Jour. Wash. Acad. Sci.*, **17** [13], 345 (1927).—The principal experimental results obtained are: (1) It has been possible for the first time to study the phenomena at practically the inversion temperature. (2) The heating and cooling curves have been obtained with a precision higher than that obtained by previous investigators. (3) There is a temperature hysteresis effect. (4) There is a discontinuity during inversion. (5) Superheating and supercooling are essential to bringing about the inversion. The inversion starts on heating at 573.30°C and on cooling at 572.38°C. (6) The discovery of the character of the inversion makes possible the application of the Phase Rule for the determination of the temperature of equilibrium of the two solid phases. This is found to be 572.68°C and is the true "inversion temperature." The long-accepted value of the inversion temperature 575°C is in error. (7) The unknown heat of transition (latent heat) has been determined at 0.162 g. cal. (8) The unknown specific heat of α-quartz at the inversion temperature is found to be 0.54 g. cal. (9) The temperature at which the inversion starts (573.30°) is a fixed and definite temperature occurring with great sharpness and suitable for a new type of base point on the thermometric scale, as well as for the standardization and checking of thermocouples in the average physical laboratory. (Abstract of original article.) A.J.M.

Unit of thermal resistance: the "fourier." D. R. HARPER. *Jour. Wash. Acad. Sci.*, **18** [17], 469–75 (1928).—H. proposes to call the practical metric unit of thermal resistance the "fourier" in honor of the foremost contributor to the theory of thermal conduction. The fourier is defined as that thermal resistance which will transfer heat energy at the rate of one joule per second (one watt) for each degree (Centigrade) temperature difference between its terminal surfaces. The "laboratory fourier" is a prism of silver or copper about 4 cm. long and 1 cm². cross-section. A table is given showing the most suitable values to use for thermal resistances of about 30 common materials. The following are of ceramic interest:

	Fouriers per cm². (20°C)		Fouriers per cm². (20°C)
Brass (30% Zn).....	0.93	Fire brick.....	200.0
Iron.....	1.6	Fire brick, 25 to 1000°....	90.0
Steel.....	2.1	Brick masonry.....	250.0
Glass.....	133.0	Wood (Va. pine).....	710.0
Concrete.....	140.0	Asbestos (wool).....	1100.0
Water.....	170.0	Air.....	4100.0
Mica (laminations)....	200.0		

The following conversion factors are useful for converting fouriers per cm². to the given units: to Calories/Second per cm². multiply by 4.18; to B.t.u./Hour per ft². multiply by 0.0172; to B.t.u./Hour per in². multiply by 0.206; to B.t.u./Second per in². multiply by 745; H.P. per ft². multiply by 44. A.J.M.

Standard units of mass remain practically constant. A. T. PIENKOWSKY. *Jour. Wash. Acad. Sci.*, **18** [18], 503 (1928).—Recomparisons of about 30 of the National Prototype Kilograms just like the International Kilogram have indicated that they, and presumably the international standard itself, are remaining constant within 0.02 mg. or less, except where there were known causes for change, and except one or two that gained about 0.02 mg. A.J.M.

Application of cinematography to study of the fall of coal particles in still water. WALDEMAR A. GOOSKOV. Amer. Inst. Min. and Met. Eng., *Tech. Pub.*, No. 18, Class F, *Min. and Met.*, **9** [263], 509 (1928).—The application of this method of examination with all the modern improvements in cinematography, to any washing process would exhibit the whole range of a phenomenon and permit a study and possible explanation thereof, as well as give direct and accurate evidence of the influence of conditions that do not lend themselves readily to exact mathematical analysis. These tests have certain possible defects, but they nevertheless do give a complete picture of the fall of certain coal grains in still water, and it has been possible to compute terminal velocities for different sizes. This is of much importance in designing jigging plants and was the object of the tests. F.P.H.

Larsenite and calcium larsenite from Franklin, N. J. C. PALACHE, L. H. BAUER, AND H. BERMAN. *Amer. Mineral.*, **13** [4], 142–44 (1928).—Larsenite is a lead-zinc orthosilicate with the formula Pb, Zn, SiO_4 and with crystallographic and optical properties which ally it to the chrysolite group of minerals. The name proposed is in honor of E. S. Larsen of Harvard University. Calcium larsenite may be represented by the formula (Pb, Ca)Zn, SiO_4, about one-half of the lead of larsenite being replaced by calcium. Its properties are closely allied to those of larsenite. Larsenite is white and transparent with adamantine luster. Cleavage is good parallel to the prism (120). Specific gravity = 5.90; biaxial negative, $2V$ about 80, $\rho > \gamma$ easily perceptible; plane of optical axes across the elongation with an optic axis practically normal to the cleavage (120); therefore $Y = c$, $X = a$, $\alpha = 1.92$, $\beta = 1.95$, $\gamma = 1.96$ (Immersion). Calcium larsenite is white and opaque with greasy luster. No distinct crystals have been found and cleavage is indistinct. Specific gravity = 4.421. Under the iron-arc spark it shows a very strong fluorescence of a lemon color, more vivid than that of willemite and easily distinguished from it. The analysis sample is biaxial negative, almost uniaxial, $2V = 5°$, $\alpha = 1.760$, $\beta = 1.769$, all $\pm$ 0.001. A second sample, looking somewhat fresher than the analyzed material, gave $\alpha = 1.762$, $\beta = 1.770$, $\gamma = 1.774$, $2V = 40°$. F.P.H.

Double dispersion method of mineral determination. R. C. EMMONS. *Amer. Mineral.*, **13** [10], 504–15 (1928).—E. experimented and collected data to improve methods for determining minerals petrographically. Two principal considerations are (1) the index for light wave length of the sodium line determined to the third decimal place instead of $\pm$.005 because of the greater detail with which minerals are becoming known and the importance of small variations in refractive index, especially as regards differences in chemical composition; (2) to increase speed of accurate study of the optical properties. Increase or decrease in refractive index is less pronounced in the denser media, though this rule is by no means universal. But in general the dispersion of liquids is greater than that of solids, and though the dispersion of solids normally increases with their refractive index, the dispersion of liquids increases even more with refractive index. Further, among liquids there is a great difference in dispersive power. If a mineral is immersed in a liquid, the refractive index of which is near that

of the mineral, then by changing the wave-length of light used it should be possible, within certain limits, to change the index of the liquid to match that of the mineral. First, the unknown may profitably be studied very briefly in the ordinary way using liquids of three or four indices if necessary in order to locate very roughly on the refractive index scale the mineral or minerals of particular interest. Then using the curves provided which show the "double dispersion" liquids on the refractive index scale, the proper liquid may be selected and a mount made. At the same time place a few drops of this liquid on the refractometer, turn on the water circulation, bringing the refractometer and the cell to the same temperature. Select a suitable grain, and by adjusting the monochromator the index of this grain and that of the liquid can usually be made to agree. Read and record the temperature, the monochromator reading, and the refractometer reading (making sure that the Amici dispersion prisms of the refractometer are set at 30 which is the neutral position proper for monochromatic light). Now change the temperature a few degrees, and adjust the monochromator to make the indices match again, and record the readings. Change the temperature once more and adjust as before. There are now available data for three correct refractive index readings on one ray. From the curve which these give the reading for light of the sodium wave length may be obtained. Also from this curve the dispersion $N_f - N_c$ for this ray of the mineral may be read. If the first selected grain is an optic axis grain, then the index is N_c or β. Next a grain of maximum birefringence may be selected and N_g determined or N_g and N_p. F.P.H.

Investigation of drying; first experimental results. V. BODIN AND P. GAILLARD. *La Ceramique*, **30** [473], 205–17 (1928).—Frequent visits to factories had shown that drying was a most difficult and deceiving process. The proper functioning of the continuous kilns depended on a sufficient supply of thoroughly dried bricks, etc. Information on drying was scanty and therefore an investigation was made. The work of d'Emile Bourry and A. Bigot was used as a guide in planning the experiments. Bourry divided the drying process into three stages: (1) shrinkage proportional to the loss of water, (2) shrinkage accompanied by the formation of voids, (3) no shrinkage, volume of voids produced proportional to the loss of water. With theoretically perfect drying, only two stages would be found; in practice, however, the three stages are found. Bourry's data and diagrams are given and discussed. Two points are emphasized: (1) Bourry ignored colloidal plasticity, and (2) with humidity drying we should be able to prolong Bourry's second stage and cause an increase in shrinkage. The work of Bigot is reviewed and compared with that of Bourry. B. and G. made a practical experimental study of accelerated drying in a current of air in a humid atmosphere and determined the maximum rate of drying in an apparatus in which the velocity of air, temperature, and humidity could be controlled. The experimental drier which was built is described in detail and a diagram is given. With this apparatus it has been possible to maintain steady conditions for 12 consecutive days. The physical and chemical properties of the 3 raw materials used in the tests were determined, and are reported. They included a marl from Fresnes, a tile clay from Marseilles, and a refractory clay from Fumel. Briquets of these materials were dried with air at 35°C with an air flow of about 6 liters per second. For the first 2 hours air at 80 to 90% humidity was used, for the remainder of the drying the lowest humidity found by trial to be effective. Tests on the 3 materials are described in detail. Curves showing the fastest practicable drying rates are given. A.E.R.W.

Early history of dialysis. SPETER. *Chem. and Ind.*, **47**, 1038 (1928).—More than 300 years before Thomas Graham, an anonymous writer published in Worms in 1529 a "Little Book of Alchemy," in which is described the purification of salt by allowing diffusion through a bladder suspended in water. H.H.S.

Silicic acid gels and their structure. R. BRUCE. *Chem. and Ind.*, **47**, 1151 (1928).—The emulsoid theory of gel structure is being replaced by a later view that the structure is that of a network of crystalline fibrils of little more than molecular dimensions separated by liquid. H.H.S.

New method for separation of zirconium and hafnium from tantalum and niobium. W. R. SCHOELLER AND E. F. WATERHOUSE. *Chem. and Ind.*, **47**, 1062 (1928).—The process is based on the precipitation of Ta and Cb as oxalo-earth acids by tannin in weakly acid solution. Zr and Hf remain in solution as oxalates. For previous article see *Ceram. Abs.*, **7** [8], 579 (1928). H.H.S.

The Raman effect in color. R. W. WOOD. *Science Supp.*, **68** [10], Oct. 5 (1928).—The recent discovery of the Hindu scientist, C. V. Raman, that intense light of a single color is partly changed to other colors when it shines on various transparent substances (such as quartz, chloroform, CCl_4, or water) has been verified by W. with improved apparatus. He regards the discovery as extremely important, opening up a new field in the study of molecular structure, and confirming the quantum theory of light. H.H.S.

The action of aluminum, ferrous and ferric iron, and manganese in base-exchange reactions. O. C. MAGISTAD. Arizona Agr. Expt. Sta., *Tech. Bull.*, **18**, 445–63 (1928).—Experiments with neutral and acid solutions of Fe and Al salts on artificial zeolites showed that the replaceable base previously present was released. The residue usually contained no H-zeolite, nor did ferric Fe or Al enter the zeolite complex in such a manner as to be replaced by other replacing agents subsequently used. Chemical analyses of zeolites before and after treatment with $AlCl_3$ in EtOH showed that there was no addition of Al or marked loss of Al or Si. Similar trials with $FeCl_3$ in H_2O and EtOH showed that Fe took the place of Al in the zeolite. This reaction was almost complete in the EtOH experiment, the zeolite residue containing practically no Al. The substitution did not take place in equivalent quantities. Soils and artificial zeolites treated with Al or ferric-salt solutions until the solutions remained acid and the previously held zeolitic bases had been removed lost all base-exchange capacity. The decrease in base-exchange capacity of zeolites and soils is a function of the concentration of the ferric Fe or Al salt solution used. Ferrous Fe as $FeSO_4$ was found to be readily exchangeable for Ca in a zeolite and in soils. A small quantity of $Fe(OH)_2$ was precipitated in the zeolite in addition and a larger quantity in soils. The ferrous Fe replacing the Ca is itself replaceable by Ba salts. Mn as $MnCl_2$ and $MnSO_4$ replaced Ca in both zeolites and soils. Some precipitation of $Mn(OH)_2$ occurred in both cases. The Mn replacing Ca is itself replaceable by Ba salts. The reaction equation for $MnSO_4$ and the particular Ca zeolite used was determined. The equation was of the same type as that for the usual base-exchange reactions. If the property of base-exchange is to be considered a factor in plant feeding, destruction of base-exchange capacity in soils by Al-containing salts, or other means, may result in serious consequences. A bibliography is appended. (*C.A.*)

Ultra-pressures of 25,000 kg. per square centimeter and their scientific applications. JAMES BASSET. *Chimie et ind.*, **Special No.**, 148–51 (April, 1928).—A description of the apparatus devised by B. for carrying out physical or chemical experiments at pressures of 25,000–30,000 kg. per sq. cm., with an outline of some of its possible scientific applications. (*C.A.*)

Preparation of alkali aluminates by action of chlorides on alumina in presence of water vapor. LOUIS HACKSPILL AND JEAN SALOMON. *Chimie et ind.*, **Special No.**, 415–16 (April, 1928).—On heating calcined Al_2O_3 and dry NaCl in a current of superheated steam the reaction $6NaCl + Al_2O_3 + 3H_2O = 2Al(ONa)_3 + 6HCl$ begins at 600° and proceeds quite rapidly. At 800°, 80% of the Al_2O_3 is transformed in 40 min.

A lower yield was obtained in vacuum than at atmospheric pressure. In the metallurgy of Al, it is necessary to use a very pure Al_2O_3, generally obtained by treating bauxite with Na_2CO_3 or NaOH. Since NaCl + $2H_2O$ in vapor form reacts like NaOH under certain conditions, 2 parts of bauxite containing too much SiO_2 to be used for the manufacture of Al (Al_2O_3 60, SiO_2 11, Fe_2O_3 4, TiO_2 3, H_2O 22%) were mixed and heated with 5 parts NaCl. After 2 hrs. at 830° Al_2O_3 was precipitated with CO_2, giving yields of 73–82% of the amount contained in the bauxite taken. A bauxite suitable for the manufacture of Al (Al_2O_3 61, SiO_2 2, Fe_2O_3 22, TiO_2 1, H_2O 14%) under the same conditions gave yields not exceeding 55%; and a bauxite of intermediate composition (SiO_2 7%) gave a 67% yield. In all cases the Fe remained insoluble but a considerable proportion of the SiO_2 was dissolved. The difference in the behavior of the Al_2O_3 is attributed to the fact that Al silicate reacts much more readily than hydrated Al_2O_3, which was confirmed by the fact that kaolin was almost quantitatively converted into $2SiO_2 \cdot Al_2O_3 \cdot 2Na_2O$ in 2 hrs. at 900° and atmospheric pressure. (*C.A.*)

Constitution of the silicates. W. Wahl. *Z. Krist.*, **66**, 33–72 (1927).—Structural formulas are derived for complex alkali aluminosilicates having an equal number of Al and alkali metal atoms on the assumption of a complex univalent anion of which the central Al atom is quadrivalent. More complex anions are formed by the union of SiO_3 or Si_2O_5 groups. In those compounds having a fewer number of Al than alkali atoms certain of the former are regarded as sexavalent, the complex anions being then tervalent. Similar types of formulas are proposed for the alkaline earth aluminosilicates. Compounds containing H are in many cases regarded as acid salts, and their formulas are derived on this principle and on those given above. *Ibid.*, 173–90.—The structure of the additive compounds formed between aluminosilicates and inorganic salts is discussed. Natural nonaluminiferous silicates are regarded as salts of complex anions containing sexavalent Si; more complex types of anions are produced by the linking of SiO_2 groups by O chains. Minerals of the pyroxene, amphibole and mellilite groups are formulated on the hypothesis of bridge formation by SiO_3 groups and O atoms. The structure and mode of polymerization of the complex silicates are surveyed in the light of their infrared absorption spectra. (*C.A.*)

Constitution of aluminosilicates, conditions of their formation, and transformation in soil. W. Wahl. *Finska Kemistsamfundets Medd.*, **36**, 22–61 (1927); cf. preceding abstract.—In these silicates which are formed at high temperatures Al has a coördination number 4, while for those formed at low temperatures it tends to be 6. Formulas with 2 Al atoms are improbable; in the crystalline state the aluminosilicates are highly polymerized. The reactions leading to the formation of minerals in the magma consist of (*a*) dehydration processes and (*b*) additive reactions; the effect of these processes is traced in the formation of hornblende and muscovite. The formation of biotite is summarized as follows: (1) $6K[Al^{IV}O(SiO_3)] + 12H_2O = K_6H_{12}[Al_6^{VI}O_6(OH)_{12}(SiO_3)_6]$, (2) $6Mg_2SiO_4 + 12H_2O = 6MgSiO_2(OH)_2 + 6Mg(OH)_2$, (3) $K_6H_{12}[Al_6^{VI}O_6(OH)_{12}(SiO_3)_6] + 6MgSiO_2(OH)_2 = K_6H_{12}[Al_6^{VI}O_6(SiO_2)_6(MgSiO_4)_6] + 12H_2O$, (4) $(K,H)_6H_{12}[Al_6^{VI}O_6(SiO_2)_6(MgSiO_4)_6] + 6Mg(OH)_2 = (K,H)_6Mg_6[Al_6^{VI}O_6(SiO_3)_6(MgSiO_4)_6] + 12H_2O$. (*C.A.*)

Investigations on silicates. E. Cherbuliez and P. Rosenberg. *Helv. Chim. Acta*, **11**, 731–50 (1928).—A study of the conductivity will detect and record the reactions taking place in the silicates at high temperature. Silicates of the orthoclase or leucite types begin to dissociate at about 800°, *i.e.*, below their melting point; SiO_2 is formed, together with a silicate poor in silica, probably of the nephelite type. This reaction is detected by an increase of the conductivity at constant temperature; it is monomolecular and reversible. An equilibrium exists between silicates of the orthoclase, albite, leucite type on the one side and SiO_2 + a silicate of the nephelite type on

the other side. An increase of the temperature favors this second phase. A mixture of nephelite and quartz heated at 900–1000° presents a decrease of its condition at constant temperature. This proves that the mixture is reacting in the opposite direction, forming a silicate of the orthoclase type. (*C.A.*)

Some early industries in the U.S. WM. V. SESSIONS. *Jour. Chem. Education*, **5**, 922–28 (1928).—A historical sketch covering chemical industries from Colonial times to the middle of the 19th century. (*C.A.*)

Support of graduate research in chemistry in American Universities, 1927–1928. CLARENCE J. WEST AND CALLIE HULL. *Jour. Chem. Education*, **5**, 1005–14 (1928). (*C.A.*)

The change of the hydrogen-ion concentration of stable kaolin suspensions due to mechanical agitation in capillary tubes. ALICE JEPPESEN. *Kolloid-Zeit.*, **45**, 156–58 (1928).—The decrease in the p_H of kaolin suspensions with time is attributed to an increase of the adsorbing surface. (*C.A.*)

The eutectic in binary systems. E. KORDES. *Metallbörse*, **17**, 481–82, 541; *Chem. Zentr.*, **II**, 8 (1927).—New equations are given for calculating the eutectic temperature and composition of eutectic mixtures from the freezing points of the pure components. The depression of the eutectic point increases in systems with components of similar character in the following order: Molecular compounds < ternary electrolyte < binary electrolytes < elements. A study of the influence of associations of pure compounds which takes place during fusion showed in systems with 2 binary electrolytes for the eutectic point depression the following order: neither component associated < both components associated < only 1 component associated, while the freezing-point depression diminishes up to the beginning of crystallization in dilute solutions because of association. (*C.A.*)

Theory of plastic deformations. FRIEDRICH KÖRBER AND ERICH SIEBEL. *Naturwissenschaften*, **16**, 408–12 (1928).—It is assumed that plastic deformations take place by 2 equivalent systems of slip planes with their axes perpendicular to an external main stress direction and crossed over an angle depending on the average main stress. Each system consists of 2 perpendicular sets of slip planes at a 45° angle with the external main stress direction. The theory is essentially an elaboration of that of Rŏs and Eichinger. The slip planes are not crystallographic planes but average empirical ones. The theory accounts for observations on contraction of stressed flat bands. (*C.A.*)

The system alumina–water. GUSTAV F. HÜTTIG AND EBERHARD VON WITTGENSTEIN. *Z. anorg. allgem. Chem.*, **171**, 323–43(1928).—The same method and apparatus have been used for the system Al_2O_3–H_2O as in previous investigations (cf. *C. A.* **15**, 2597; **16**, 3280; **17**, 2542). The following points are examined: colloid system Al_2O_3–H_2O; transformation of an amorphous colloid system into a macroscopic crystalline system; hydrargillite and its dehydration products; products obtained by the aging of the colloid system Al_2O_3–H_2O; diaspore and its dehydration products; effect of high temperatures and high water-vapor pressure; activity of Al_2O_3 and $Al(OH)_3$. (*C.A.*)

Heating powdered substances below their melting points and eutectic temperatures. BERNWARD GARRE. *Zement*, **17**, 446–48 (1928).—The reactivity of powdered solids on heating below their melting point or eutectic temperatures is aided by compacting into pellets or by mixing with liquids, especially those liquids in which one or both solids are soluble. (*C.A.*)

BOOKS

Viscosity of Liquids. EMIL HATSCHEK. G. Bell & Sons, London, 1928. Price 15*s*.—Investigations of great importance, hitherto unavailable in any convenient form, are here summarized for the first time. H.H.S.

Volumetric Analysis. Vol. I. Theoretical Principles. I. M. KOLTHOFF AND

H. MENZEL. 289 pp. John Wiley & Sons, Inc., New York, 1928. Price $3.00.—In addition to the general information on volumetric work it contains chapters on titration graphs, the titration error, speed of reaction, adsorption phenomena in precipitates, stability of solutions, and volumetric methods in organic chemistry. Translated from the German by N. H. Furman. H.H.S.

New books on science. ANON. *Chem. and Ind.*, **47**, 1109–27 (1928).—The autumn review number of books published in English, French, and German, includes: (*a*) reviews of 20 books, among them the new volume of Mellor's "Comprehensive Chemistry," the new editions of Svedberg's "Colloid Chemistry" and Lunge and Keane's "Technical Analysis," and Trelease and Yule's "Preparation of Scientific and Technical Papers;" (*b*) a classified list of books reviewed during the last six months; and (*c*) new and forthcoming books of the leading English and American publishers. There are also articles on scientific writing and on the chemist and his message. H.H.S.

Physico-Chemical Tables. I. HANS LANDOLT AND RICHARD BORNSTEIN. 5th ed., revised and enlarged. Edited by Walter A. Roth and Karl Scheel. J. Springer, Berlin, 919 pp. (*C.A.*)

Bibliography of Crystal Structure. JARED KIRTLAND MORSE. University of Chicago Press, 1928. 164 pp. $3.00. Reviewed in *Min. and Met.*, **9** [263], 520 (1928); *Can. Chem. Met.*, **12** [11], 52(1928).—The scope of this work is broader than its title, consisting of an introduction covering the work and the equipment of the crystal structure laboratory of the Univ. of Chicago. Part I contains six short papers on crystal structure, five of which are by M., and Part II is the bibliography of crystal structure for the period 1912 to 1927, arranged by years and authors. F.P.H.

Atomic Structure as Modified by Oxidation and Reduction. WILLIAM COLEBROOK REYNOLDS. Longmans, Green and Co., 1928. 128 pp. $3.00. Reviewed in *Min. and Met.*, **9** [263], 520 (1928).—Starting with the theory that changes in the states of oxidation or reduction causes corresponding alterations in the atomic structures of chemical elements, R. submits this view to a theoretical investigation, the results of which are recorded briefly in this book. He advances arguments in support of the theory and discusses the bearing of these changes on the periodic classification, the structure of molecules, solid conductors of electricity and magnets, and upon the properties of chromophores. He advances arguments to prove that the ether is nonhomogeneous. F.P.H.

Industrial Chemistry. E. R. RIEGEL. 650 pp. Chemical Catalog Co., New York. Price $9.00.—The book is both a text and history of modern industrial chemical events. The fifty chapters deal with economics and general information about the industry. Reviewed in *Can. Chem. Met.*, **12** [11], 52 (1928). E.J.V.

General

Effect of heat treatment on diatomaceous earth. HOBART M. KRANER. *Jour. Amer. Ceram. Soc.*, **11** [12], 875–83 (1928).—This paper deals with the heat treatment of diatomaceous earths collected from a few commercial deposits throughout the country. It was originally intended to study the effect of heat treatment upon the various types of diatoms which occur in these various deposits. The results of the study indicate that the change of structure incident upon higher heat treatment is more dependent upon the chemical composition (impurities) than upon the diatom structure. An air-floated sample which was quite pure showed little deterioration up to 1300°C.

Leisure, the most valuable possession. EDITORIAL. *Bull. Amer. Ceram. Soc.*, **7** [11], 317–18(1928).—Leisure, if properly used, is one's most valuable possession. It is pointed out that school training must be forced and cultivated. With progress in mechanical means for manufacturing and transporting, and the increase in means for

education and culture, people have more time to use as they wish. One who would keep abreast of things must use this leisure time in studying and in classifying available knowledge. The organized collaboration, which the AMERICAN CERAMIC SOCIETY affords, instils the incentive for promoting education for service in the ceramic industries and for converting our leisure hours into valuable possessions. E.J.V.

College education in ceramic technology. H. F. STALEY. *Bull. Amer. Ceram. Soc.*, **7** [11], 319–20 (1928).—No college in the U.S. at the present time is offering a general ceramic curriculum. The so-called curricula in ceramic education offered at various schools are really specialized courses in clay products technology, with a little glass or enamel technology added. No adequate preparation is offered for entrance into the glass or enamel industries. Such curricula should be called courses in clay products technology. Either the establishment of specific curricula in clay products technology, enamel technology, and glass technology, or the lengthening of the present course to five years in order to be able to add the necessary fundamental courses to round out the training for any of the three branches of ceramics is urged. E.J.V.

Production of miscellaneous nonmetallic products increased. ANON. *Can. Chem. Met.*, **12** [10], 42 (1928).—The 1927 output of 31 plants operating in the miscellaneous nonmetallic mineral products industry in Canada was substantially larger than that of the preceding year, amounting to $10,231,304, an increase of 19% over 1926. In this group were included 11 plants making artificial abrasives or abrasive products, 3 plants manufacturing electrodes, 4 gypsum products, 9 mica trimming shops, and 4 foundry facings and supplies. The value of artificial abrasives, such as fused alumina and crude silicon carbide, and abrasive products such as abrasive wheels, paper, cloth, etc., produced last year amounted to $6,106,794, as compared with $6,081,822 in 1926. Artificial abrasives were produced in 4 plants in Ontario and 1 in Quebec; and grinding wheels, sandpaper, etc., in 7 Ontario factories. The value of the output of the 7 plants manufacturing gypsum products, including gypsum wall board, wall coating, and gypsum blocks as their main products, totalled $2,292,428. There were 9 mica trimming shops (8 in Quebec and 1 in Ontario) operating last year, with a total production worth $285,555. Two plants in Ontario and one in Quebec manufactured graphite and carbon electrodes as their main product, the output for the year amounting to $1,457,722. The production of the four Quebec plants making foundry facings and supplies totalled $88,805. E.J.V.

Society of Glass Technology. ANON. *Pottery Gaz.*, **53** [617], 1766–68 (1928).—A report of the meeting held Sept. 21, 1928, at which the following papers were presented: "The Value of the Thermal Expansion Factor of Aluminum Oxide in Glass," by I. Kitaigorodsky and S. Rodin; and "A Study of the Ultra-violet Light Transmission of Glass," by D. Starkie and W. E. S. Turner. E.J.V.

Glass convention. ANON. *Pottery Gaz.*, **53** [617], 1769–77 (1928).—The general sessions of the Bournemouth Glass Convention were devoted to a consideration and discussion of the subjects of "Organization and Rationalization in the Glass Industry" and "Legislation in the Glass Industry." W. E. S. Turner also broadcast a talk on "Glassmaking in Britain." E.J.V.

Indian Ceramic Society. ANON. *Pottery Gaz.*, **53** [617], 1780–81 (1928).—A brief history of the Indian Ceramic Society founded in April, 1928, is given, with a list of the officers. The first issue of its Journal is dated September, 1928, and is edited by T. W. Talwalkar, Secretary of the Society. It contains a short directory of ceramic schools and research laboratories in India. E.J.V.

Polishing supply salesmen meet. ANON. *Abrasive Ind.*, **9** [11], 289 (1928).—The Hanson-VanWinkle-Munning Co., Matawan, N. J., held its annual sales convention at Asbury Park, N. J., Sept. 11 to 15. E.P.R.

Abrasive men hold annual meeting. ANON. *Abrasive Ind.*, **9** [11], 291 (1928).—The annual meeting of the Grinding Wheel Mfrs. Assn. of the U.S. and Canada was held at Lenox, Mass., Sept. 28 to 29. E.P.R.

Exhibit modern abrasive tools of American and British design. VINCENT DELPORT. *Abrasive Ind.*, **9** [11], 292–93 (1928).—A number of grinding machines and a comprehensive display of grinding equipment were shown at the fourth machine tool and engineering exhibition at Olympia, London, by the Machine Tool Trades Assn., Sept. 5 to 22. E.P.R.

Exhibit abrasive appliances. ANON. *Abrasive Ind.*, **9** [11], 293 (1928).—The recent exhibit held in Cleveland, in connection with the 47th annual convention of the American Electric Railway Assn., included several interesting abrasive appliances. E.P.R.

Abrasive equipment featured at metals exposition. ANON. *Abrasive Ind.*, **9** [11], 304 (1928).—Products of 160 firms were displayed in the 1928 National Metal Exposition held in the Commercial Museum, Philadelphia, Oct. 8 to 12, sponsored by the American Society for Steel Treating. E.P.R.

Rise of distribution costs. LLOYD RING COLEMAN. *Amer. Glass Rev.*, **47** [53], 17 (1928).—The hope that the trend of the distribution cost graph will follow the descending curve marked out by production is baseless. New and complex psychological facts are involved in distribution, facts with which production is not concerned. Solution of a production problem is permanent until something better takes its place. With distribution almost the exact reverse is true. In the U. S. the cost of distribution and the number of people concerned exceed the proportion anywhere else. The latest census shows that salesmen have numerically the strongest profession. Yet salesmanship is only one branch of distribution. All railroad workers and drivers of commercial vehicles should be included. To believe that to be educated once is to be educated always, or to believe that a taste remains, once the public has adopted it, is wrong. The manufacturer pays for this education. The more difficult it is to sell an article the more the consumer must pay for it. If the entire production of the U.S. had to be sold direct to the customer it would drop off about 50% the first week, and decline progressively from then on. People buy only when they have been sold particularly, as well as generally, on an article. They must be made to desire it vaguely by national advertising. Then the sale must be made at the point of contact where the goods are displayed or where a salesman makes them attractive enough to be irresistible. E.P.R.

Boiler plant of Klingenberg power-station. F. MUNZINGER. *Mech. World*, **84** [2169], 83(1928); *Z. Ver. deut. Ing.*, **71**, 1855–68 (1927).—The boiler plant consists of 16 boilers, each with a heating surface of 1800 sq. m., which generate steam at a pressure of 35 atmospheres absolute, and at a temperature of 410°C. Each boiler has a maximum continuous evaporation of about 270,000 lbs. per hour. With a 3-drum boiler, the outer diameter of the drums being 1500 mm., it was found possible to obtain the heating-surface of 1800 sq. m. The tubes are bent, and the drums are divided in half, lengthwise of the upper drums. Chain-grate stokers were abandoned in view of the large quantity of coal used, and pulverized fuel on the central system was adopted. E.P.R.

The hydraulic handling of ashes. A. M. QUINN. *Mech. World*, **94** [2169], 88 (1928).—Certain outstanding plants prior to 1923 installed hydraulic methods of ash handling. Modern hydraulic ash handling is particularly applicable to ash from pulverized-fuel furnaces. It is found that about 25% of the total ash from powdered coal is collected in the ash-pit, another 15 to 20% from the second pass of the boiler, from hoppers beneath the economizers or air heaters, from flues, and from the base of the stacks. A horizontal sluiceway may be used to collect dust from many sources through comparatively small pipes. By carrying this dust mixed with water none of the problems of flow angles enter, resulting in simplicity of design. E.P.R.

Improved multiple-retort stoker. ANON. *Mech. World*, **84** [2171], 123 (1928).—In the field of the water-cooled boiler a noteworthy feature is the progress during the past three or four years of mechanical stokers in competition with pulverized fuel, especially on the multiple-retort principle. This has a number of general advantages, such as absence of firebrick arches, direct radiation of the heat to the boiler-tubes, etc. The latest design of the "Underfeed Type F" stoker embodies a number of important additional advantages, being especially intended for high evaporation and the use of medium coking coals. E.P.R.

Care of factory chimneys. E. INGHAM. *Mech. World*, **84** [2171], 130–31 (1928). E.P.R.

Relation of furnace volume to combustion efficiency. HARRY JACOBS. *Mech. World*, **84** [2171], 133–34 (1928).—The basis of steam generation can be divided into three main factors: (*a*) crude or original source of heat, such as oil or coal, etc.; (*b*) conversion into heat or B.t.u.; (*c*) transposing of B.t.u. into a medium that can be controlled, such as steam. These three factors are discussed in detail. The present combustion-chamber volume is much greater than was used in the early days, where the furnace volume was limited to a few cubic inches to the pound of coal burned. In some modern settings 8 cu. ft. of combustion chamber have been allowed per H.P. developed. The only argument against such a large size combustion chamber is the cost of brickwork and maintenance in relation to added efficiency obtained. The fusing point of fire brick is another consideration in combustion efficiency. Few people consider that as weight is imposed on fire brick its fusing point is lowered, so it becomes obvious that in designing a chamber some method must be employed that will not impose excessive weight on the lower part of the brick. If this is done, the next consideration is the allowance of sufficient expansion space so that the brick will not create a self-imposed pressure. E.P.R.

National Association of Clayworks Managers. ANON. *Refract. Jour.*, **3** [36], 949–52 (1928).—A meeting of the Sheffield Branch of the National Assn. of Clayworks Managers was held at the Royal Victoria Hotel, Sheffield, June 20, 1928. A paper on "Modern Lubrication and Lubricants" was presented by F. C. Stephan. E.P.R.

Refractory materials meeting. ANON. *Refract. Jour.*, **3** [36], 965 (1928).—The twentieth meeting of the refractory materials section of the Ceramic Society was held in Glasgow, September 13 and 14. E.P.R.

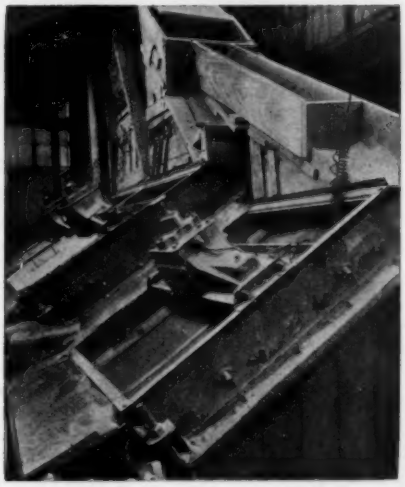
Building Materials Section. ANON. *Refract. Jour.*, **3** [36], 966 (1928).—The first Annual Meeting of the Building Materials Section of the Ceramic Society was held at North Staffordshire Technical College, October 10 and 11. A paper on "Modern Facing Brick" by A. B. Searle, one on "Modern Brick and Tile Machinery," by the Pragos Engineering Co., and one on "Scumming and Efflorescence of Brickwork" by W. A. McIntyre and R. J. Schaeffer, were presented. E.P.R.

High pressure steam boilers. G. A. ORROK. *Blast Fur. Steel Plant*, **16** [10], 1332–36 (1928).—A review is made of construction features in high pressure steam generation. Places at which high cost materials must be employed are pointed out. F.P.H.

Practical points on feed water treatment. J. GUEST. *Blast Fur. Steel Plant*, **16** [11], 1461–65 (1928).—Various methods of treatment are reviewed, both with regard to results obtained and the routine of application. Operating costs are discussed. F.P.H.

Modernization of ceramic processes, materials, and machinery. ANON. *Ceram. Ind.*, **11** [5], 453 (1928). F.P.H.

Federation of technical division of American Refractories Institute with American Ceramic Society. ANON. *Ceram. Ind.*, **11** [5], 506 (1928). F.P.H.



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6007 Euclid Avenue, Cleveland, Ohio

BULLETIN

of the

AMERICAN CERAMIC SOCIETY

A Monthly Publication Devoted to Proceedings of the Society, Discussions of Plant Problems, Discussions of Technical, Scientific, and Art Questions and Promotion of Coöperative Research

Edited by the Secretary of the Society Assisted by Officers of the Industrial Divisions

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EDITORIALS

BEAUTIFYING GLASS[1]

BY H. S. NASH

In an analysis of art it is possible to pick out such principles as mass, line, balance, rhythm, and color. But because in a creative sense there is no formula for their use it is easy to understand why minds trained to a scientific attitude are apt to underestimate this art which cannot be mathematically synthesized. In spite of this mistrust which arises from superficial conceptions of the purpose of art, and a libelous use of the word itself we have reached a point where intelligent industry is willing to concede that there is something fundamental and sane in the creation of beauty. It is beginning to understand that the cause and effect of loveliness, for all its elusive mechanics, are as sound and basic as any process in its research laboratory; it is beginning to recognize that a feeling for loveliness, an ability to express personality, and creative imagination are more than vague words; they are attributes as concrete for an artist as a feeling for mechanical construction, a genius for organizing, or the ability to direct men are for leaders in other fields.

[1] Presented at the Annual Meeting, AMERICAN CERAMIC SOCIETY, Atlantic City N. J., February, 1928. (Art Division.)

An executive does not take a man who can write an excellent hand and make him advertising or sales manager, even though he may be able to copy an unusually fine sales talk and substitute the name of the product to be sold for the original one. The most encouraging thing that can be said of modern industry is that it is learning to distinguish between draftsmanship and creative expression, that it can understand that the ability to draw is in a true sense of no more consequence in an artist than the gift of penmanship is in an author.

Two years ago the writer ventured the opinion that good design has a direct, positive relationship to profit. Following closely upon that discussion, one of the large manufacturers of glass articles sold popularly in five and ten cent stores submitted to a jury of three persons with a background in design some two dozen samples of his product. In general, it was found that the pieces judged by the jury to be the most acceptable from the standpoint of design were the best sellers. Recent developments in the automobile industry serve to stress the same idea, the importance of beauty as a selling factor.

From another angle there is a factor of even greater importance. We have developed an age of machinery. Our problem in artistic expression is to master the machine. This means finding expression in terms appropriate to modern life through machine processes. The development of our industrial arts is an economic achievement necessary for the country's growth.

We shall limit ourselves to three basic elements in glassware design: the nature of the material, the use of the object, and the limitations of the method of manufacture. We consider beauty in the useful arts to be the ability of an object to express charmingly and within the inherent limitations of its material a character in fine accord with the purpose for which the object is intended.

There is first the nature of the material, in this instance glass. It is not enough that the material be recognized as glass. The shape of the object, its color, and its texture, which includes surface decoration, should all offer a positive contribution to a feeling of glassiness. There are two departures commonly made from this criterion. One is the intended imitation of such materials as silk, paper, and metal. Such imitation not only places the article definitely outside any claim to art because of its insincerity, but it constitutes in its weak defense the most flattering recognition of the artistic superiority of the material imitated. This is the most apparent weakness of lighting glassware. The other departure is usually unintentional, and is largely a sin of omission. Without purposely giving a glass object the character of some other material designers often neglect to take advantage of line and texture to enhance the glassy character of the object. This neglect is most apparent in the design of glass containers.

The part which the use of an object plays in its design is called its expression or its personality; and it is not the altogether simple thing the statement might imply. One might imagine that if a container be of proper capacity and good visibility, or if a shade diffuse light satisfactorily this element might be satisfied. Essential though these be, there is more to be said if art is to accomplish its full purpose. We have said that to be sincerely beautiful a glass object must express what it has to say in the language of glass. Now we add that what it says must be interesting and pertinent to the company it keeps.

We employ a most subtle psychology in our advertising to create very definite reactions to the products advertised. A successful ad does not state simply that a food is wholesome, that a coat has style, or that a magazine is humorous. The essence of good advertising is to create an ad which is the embodiment of the character or qualities we wish to be associated with the article advertised. Its success does not lie in its prettiness, its elaborateness, or its slavish adherence to some other ad that might have successfully created a demand for an entirely different kind of ware under totally different living conditions. Its success depends on its ability to correlate the desirable traits of the object with the needs of a specific market, and so by eliminating all nonessentials build up an atmosphere of convincing truth. This matter of convincing expression is one of the most fundamental elements of art, its best reason for existence, and in the useful arts the least regarded.

An inanimate object may in the hands of an artist become a personality and express such very definite traits as generosity, sympathy, boldness, honesty, reticence, strength, dignity, and elusiveness. An article may be drab or sensuous, it may be weak or virile without any naturalistic representation and no other tools than the intelligent use of line, color, and texture. It is silly to think of adjusting design to allow objects to be classified as art. Art is not the goal, art is the opportunity. Without it we have a hollow receptacle of a good quality flint glass filled with pickles, every one photographically defined. With it a modest little jar could touch our very hearts, so genuinely sincere is its homely mission.

Here are no strait-laced sides of puritanical angularity. Its simple curves are plump and full as any unspoiled rustic. Sturdy in its lack of elegance, honest in its denial of pretence, its sides are bursting with goodness, and its smooth lipped generous mouth is an invitation not to be resisted. There are places where one may catch a glimpse of pickles, crisp and juicy, but it is a wise little jar that has learned to deny the sight of all its treasures.

These may sound like sentimental words, but some day art will create such a jar, machinery will produce it, and pickles will sell in it as they have sold in nothing else.

The third element included in this idea of design to fit modern conditions is the place of the machine and of quantity production. It would be foolish to argue their desirability. They are here and they fill an economic need. As far as popular reactions to the present products of industry are concerned, the natural tendency has been to accept the wizardry of mechanical method as an end in itself. It has seemed marvelous enough to look at the seemingly endless varieties of novel effects it can produce. We have outgrown our curiosity now, and we are accustomed to the inexpensiveness of the article produced in quantity. These can no longer substitute for sound basic design, and progressive manufacturers recognize the fact. A new art which recognizes and expresses the present cannot be born in a day, but it is coming and it will come the more quickly when the manufacturer who comprehends the true significance of art becomes associated with the artist who recognizes the economic and spiritual possibilities of the machine.

Why we have not reached this stage sooner may be partly the fault of the manufacturer, but it is also due to the fact that educational authorities have only recently recognized the fact that sincere art is not the evasion of modern civilization by slavish copying of traditional art that expressed another time.

No one wishes to dispute the loveliness of traditional art, but, as John Erskine has it, if we believe in tradition, we shall want it to go on. Of course it is not so easy to express this new, fast moving age of virile growth as it is to borrow the already finished niceties of historic style. What of it? Scientific success has not been achieved without infinite labor and imagination amounting to genius. Artistic triumph (including art that means dollars and cents) will not follow the development of draftsmen who learn to adapt the art of another age to suit this one. It will follow the discernment of artists who, understanding the rock bottom principles that made historic styles adequate and expressive for the age in which they appeared, can use them to create an art that is sincerely expressive of this age. This he must do with a full understanding of the limitations and possibilities of modern methods of production. Our art is in very much the same state as our religion, it carries too much sentimentality, popular error, and meaningless detail.

It is on the foregoing conception of what art progress should be that the writer offers some comments on the present state of glassware design in the United States. Lighting glassware falls short of its possibilities. Too much of it is mistakenly made in imitation of other materials, much of it is obviously designed independently of the fixture which is to carry it, and most of it is designed without a thoughtful consideration as to its relation to good home furnishing. Manufacturers are conscious that in general the right note has not been struck and at the present time there is crystallizing

in their trade association a plan to establish a laboratory in which their problems may be studied.

It should be said in extenuation of the industry that with the possible exception of one there is no school in the country that offers preparation for designers of glassware in industry. The writer is acquainted with several manufacturers who have expressed their willingness to employ designers with a requisite background if they were available.

Without attempting to offer a solution for its difficulties the writer feels that some suggestions as to its betterment might at least stimulate thought. Nothing can be accomplished unless the industry will work together as an association for its common good. In spite of the appearance of some good examples of lighting glassware the general atmosphere of such a salesroom is far from wholesome. That impression must be changed, and one or two manufacturers cannot do it alone. Too often the distributor of such glass is an electrical contractor whose taste in home furnishings is markedly inferior to that of his customers. He buys what he likes, and he sells what he has because he has nothing better. Even though he may be able to sell it, if the ware is not a healthy expression artistically it will eventually destroy itself altogether.

The illuminating glassware manufacturers could, by suppressing a few selfish interests and working as a unit, dictate a new style based on sound artistic principles among which imitation has no standing. Such a program might involve the calling in of sane specialists in home furnishing, and architects, and persons competent to evaluate the fitness of color and design. It might involve the contemplated research laboratory. Just what the new style will be it is difficult to say, but the personal feeling of the writer is that it will be made up largely of crystal or clouded glass in preference to the more or less opaque white, that it will depend for its diffusion of light more on color and texture than opacity, and that its decoration will be oftener modeled or etched ornament than applied brushwork or decalcomania. A possible exception might be the development of a transfer to give the depth of transparent glass colors, though such a transfer would have to be made by some process other than lithography.

The emphasis of the new style will not be so much on shaded light as on the glorification of light. Modeling will not be used as a decoration on its own account, color will not be employed to represent a pretty picture or a gaudy bird for its own interest. The program will be to use color and texture to make light beautiful. Other materials will shade light as well as glass, but there is no common material other than glass that can create a symphony from an incandescent bulb, and if this urge toward modern expression based on sincerity continues to make itself increasingly felt, then it is logical to expect the candle fixture to lose caste too, since it is built on a false tradition.

One does not demand quite so much of the glass container since it is only within recent years that the value of artistic expression in such articles has come to be generally recognized. As a matter of fact there is no branch of the glass industry to which art offers greater opportunity than that of the glass container. The more necessary and the more intimate to our everyday needs an object becomes, the more actual is its opportunity to be companionable, that is, the ability to waken confidence in the qualities it represents.

One manufacturer is endeavoring to use the theory of dynamic symmetry in the design of his containers, and such a definite program toward a finer design is most worth while. The weakness of the program lies in the fact that the theory takes into account good form only as abstract form. In other words it does not help to achieve a form that is essentially a glass form, and it does not take into consideration any specific feeling of use which the object should express.

A successful author creates people who are convincing and interesting because in their actions, their thoughts, and even in their dress they ring true to the parts they play. This is the opportunity art offers to industry, to make living, speaking personalities of inanimate abstract forms, and though industry may not be consciously aware of it, it is taking definite steps in that direction.

In the commercial production of a clear flint glass to permit the fullest expression of such luscious colors as those of syrups and vinegar, in the minimizing of labels whose importance becomes less and less as the expression of the container becomes more adequate, and in the transference of unsightly molded letters to the bottom of the vessel there is a positive admission that the language of design is far more convincing than the printed word. Another evidence of this awakening is in the fact that manufacturers of containers are beginning to seek the advice of designers who have studied the problem of what a container should express in relation to its final destination in the home.

A container serves a humble purpose, and it but adds to its sincerity if it admits it. For example, there is nothing to be gained by cutting the sides of a jar into a number of panels for no other purpose than to hide a seam. Some of the most spontaneous and highly priced pieces of Ming procelain are proud of their seams. The design of a container includes its cap or stopper. The distortion of a lip to accommodate an unsightly cover is enough to ruin what might otherwise be an attractive article. With the present equipment for manufacturing covers there should be no difficulty in making practical ones that add to the distinction of a container.

Colored foil, or glass covers, or corks covered with a colored shrunk-on cap of gelatin or nitrocellulose seem to be most fitting for glass.

There seems to be no longer any good reason for labels except as very

small identification marks or on containers that must carry directions for use. The development of national advertising makes the use of advertising matter on labels quite useless. The one word Heinz is all the purchaser needs to read or does read on a bottle of Heinz ketchup. A nationally advertised product gains dignity by not having to blow its own horn. The fitting use of labels is exemplified in many of the finer perfume containers, and there is no reason why that fitness should not be carried to many other types of containers.

It is probably heretical to suggest that complete visibility of a product in a glass container is not always desirable, but it is sound psychology, easy to prove, that suggestion is capable of creating a greater and more lasting interest than blatant frankness. This suggestion may be achieved by the intelligent use of modeled ornament on part of the container to partially conceal the contained product. There is also an opportunity to employ colored glasses of not too great intensity to lend interest to materials which are not sufficiently colorful themselves.

The design of glass containers is no simple matter to be left to mediocre designers. It is an art worthy of the finest talent.

Of tableware we shall say little. Fortunately, there are in the country a number of large manufactories whose product is distinctly worthy of emulation, and the size of these factories guarantees a leadership in fine things that is raising the level of the whole industry. A great deal of it is quite sane and lovely. Here and there are examples of forced novelty in shapes that are too elaborate and fussy for this age of directness. Sometimes there is a misunderstanding of color, particularly in the application of one colored glass as ornament to another, so that there is a feeling of dissention and rivalry between its parts. An object cannot be companionable if it creates a feeling of uneasiness and though pure color has its place in glass, it must be used with care and discrimination.

It is most encouraging to find plenty of examples of glass that show a fine understanding of method of decoration and the feeling they should express. Pressed glass with its shimmering detail, solid figures with an almost liquid loveliness, the increased use of colors that are subtle rather than raw, and most astounding of all the courage of manufacturers who pride themselves on their ability to make flawless material to humanize their glass with just a little bit of human error, these comprise sufficient evidence to expect much from the industry.

WHAT I LOOK FOR AS A CONSUMER OF CERAMICS[1]

By Evelyn T. Openhym

With so much labor transferred from manual to mechanical, there has accumulated a tremendous amount of leisure among the American people and we may well wonder what is done with it.

This may sound like a very strange statement, for as Americans we are accused of so filling our day that to accomplish all we rush madly from one activity to another. But these activities are not all drudgery, and many of them which we enjoy were once considered as belonging only to the so-called "leisured class." Foremost among these pursuits is America's quest for beauty; this in spite of such men as H. L. Mencken, Lewis Mumford, Glenn Frank, and Hendrik Van Loon "who go about weeping and wailing over America's lack of beauty and the spiritual crisis that consequently confronts her."

It would seem that mechanical improvement is reaching its apex; at least there is not so much monopoly on mechanical perfection. The manufacturer of elevators, automobiles, vacuum cleaners, refrigerators, etc., are discovering that to successfully compete he must use good form and color, two essential aspects of beauty. Machines are native with us to a great extent, and the effort to beautify them has created a new field of artistic endeavor, *e.g.*, the elevator, the phonograph, the radio, the motor car. Henry Ford changed the model of his car because he found that people were buying other cars of equal performance and approximate cost because of their greater beauty.

And so the ceramist is finding that the products he manufactures must meet the demand of the purchasing householder, who, after all, is his greatest client. We have found that an article may be beautiful as well as useful. "The immaculate paleness of the hospital" is disappearing from our kitchens, pantries, and bathrooms. Colored enameled kitchenware is much in demand; it is meeting the housewife's approval. It is not at all difficult to work out almost any desired color note in the kitchen for the needs are admirably met by the manufacturer.

The bathrooom is being lined with colored tiles which are, after all, just as sanitary as the white ones, and more restful to the eye. But filling the cupboard shelves with dishes and tableware appropriate to the increased use of color is a more difficult task.

We have learned to respect and admire the quality of wood as a decided asset to the furnishing of our home, and we have learned that it is far too lovely to be covered, hence the advent of luncheon sets. Pure white does

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[1] Presented at the Annual Meeting, American Ceramic Society, Atlantic City, N. J., February, 1928. (Art Division.)

not seem to belong to the rich quality of wood, therefore the varying shades of cream, yellow, green, and a variety of other colors are used.

It is only natural, then, that dishes other than dead white be in demand. The ivory-bodied tableware with colored decoration seems to be the most popular and satisfying. With the great strides made in lighting effects with colored glass, paper, and fabric, and with the special attention paid to the decorative use of the fixtures, we have an added medium of infinite possibility to consider in relation to our table service.

For the ivory-body, earthenware lends itself more readily than china because of the lower temperature used. Except for the ivory porcelain and belleek, china and porcelain are usually white. The range of colors on china has been somewhat limited. Since color is the cry of the hour, earthenware decorated in a wide range of colors and glazes is now satisfying the need to a certain extent. Some of it is made in this country, but the most attractive in design and color comes from abroad. Despite the high duty on ceramics, quantities of the foreign ware are flooding the market, and discriminating people are willing to pay for the more attractive article. The buying public is no more satisfied with a plate merely technically perfect than they are with buying an automobile that has only a perfect engine.

Spain and Italy are responsible for a great amount of very attractive earthenware. It gives the impression of having been designed by someone very sensitive to the nature of clay. In many instances their colors and designs are exceedingly suitable to the form. Although made in quantity by factory methods, the very nature of the forms and decoration gives them a very uncommercial aspect.

In the last five years there has been, however, an increase of interest in American-made pottery, particularly of pottery made by the individual potter in the small studio. As an evidence of this, the Potters' Shop of New York was incorporated as a center for such ware. In other large cities the various Societies of Arts and Crafts are more and more featuring this type of pottery. Lamp bases, flower vases and jars, decorative plates, tiles, garden pottery, bowls, and ash trays all find a ready sale. In many instances they are used to accent a certain desired color note in a room. The buying public is discovering that America can produce pottery which satisfies its aesthetic taste. But as yet the supply is naturally limited, and the prices on the whole rather high. Why, then, if pottery lovely in form and color can be produced in the studio of the individual potter, cannot it be made in factories where equipment is sufficient to produce in quantity? I believe that the Hull House Pottery Factory of Chicago is trying this experiment, and finding it a sound business proposition.

Too often in our shops we see ceramic articles which very frankly are in imitation of some older ware. To see Greek decoration of black figures on a Chinese form of high fired procelain is gross incongruity. The same may

be said of Chinese designs on a very low fired body, or accurate copies of American Indian designs used as underglaze decoration on a vitrified body.

In the field of glass we have made wonderful progress. The Steuben Glass of Corning is very lovely, and its wide range of exquisite colors and forms fulfils many needs. Many other American firms supply the market with glassware, equal in attractiveness and quality to that of Europe.

It is beauty that we want, but we want it in relation to our present-day needs. It is a prosperous age and the buying public, now realizing that beautiful surroundings make life much more pleasant, is willing to invest in objects of lasting loveliness. It is to be hoped that the Art Division of the AMERICAN CERAMIC SOCIETY will aid in establishing some criterion for the various ceramic products manufactured for present-day consumption.

HARTSDALE, NEW YORK

ACTIVITIES OF THE SOCIETY

AMERICAN CERAMIC WEEK

What You Ought to Know About It

Where Will It Be Held?

American Ceramic Week will be held at Chicago, February 4 to 9, inclusive. A large part of the exposition hall of 39,000 square feet of the Hotel Stevens, World's Largest Hotel, will be used for the display of equipment, materials and supplies used in the production of ceramic products. The other part of the hall will be used for the display of finished ceramic products.

Who Will Be There?

The following trade associations have agreed to hold their meetings concurrently during the week of February 4 to 9.

Association	Attendance at Their Previous Meetings
American Ceramic Society	900
American Face Brick Assn. (Divisional)	50
American Refractories Institute	80
Common Brick Manufacturers Assn.	450
Canadian National Clay Products Assn.	100
Hollow Building Tile Association	80
Illinois Clay Products Assn.	35
National Brick Manufacturers Assn.	75
Grinding Wheel Manufacturers Assn.	100
Total	1870

Besides these there will be a delegation present from the Electrical Porcelain Manufacturers Assn., the U. S. Potters Assn., the Sheet Metal Ware Assn., Glass Containers Assn., Clay Products Assn., and others.

Presidents, general managers, superintendents, foremen, technical men, and others will be included in this group.

And, in addition to this attendance, there will undoubtedly be attracted to this big event on account of the favorable location of Chicago, and on account of the many important events scheduled, many executives in the various branches of the industry who are not now members of any of the above associations. It is therefore safe to say that there will be an attendance of fully 50% more than itemized above.

Purpose

This set-up offers an unusual opportunity for the allied branches of the ceramic industries to demonstrate their importance to the world at large, to get better appropriations for ceramics at the Bureau of Standards, to coöperate better one with another in securing ceramic research at state universities commensurate with the tax monies paid by the ceramic industries, and to sell the public on the value, beauty, utility, and superiority of American ceramic ware. Through the exposition and publicity in newspapers there ought to be created a better demand for ceramic products which in turn means more business for firms selling to ceramic products manufacturers.

Cost to Exhibitor

The booth spaces at the Hotel Stevens for equipment, material, and supply firms cost from $125 to $200, depending upon size and location. This includes sign, table,

chair, partitions, moving of exhibit material to and from shipping platform (except in case of heavy machinery required by union to be moved by machinery movers at standard published rates), and storage of crates, packing, etc., during convention. The income from the exposition will be turned back to promote the welfare of the industry. In other words, this is not a mercenary exposition. After meeting all legitimate expenses of the Convention, the surplus will be turned over to the promotion of the industry through publicity and otherwise, so as to benefit ceramic products manufacturers directly and equipment and material supplies indirectly.

Advantages to Exhibitors

Exhibitors will at this one exposition be able to meet more prospects and customers than ever heretofore. The present arrangement, moreover, makes it unnecessary to spend money for several expositions, conventions, etc. It simplifies matters considerably for exhibitors to reach this large buying clientele and at the same time enables the exhibitors to demonstrate to their various associations their spirit of cooperation to make this a big event. In other words, the exhibitor is helping his customers by his investment in space and at the same time helping himself through contacts with new and old customers, and demonstration of his coöperation.

DISCUSSION ON PROPOSED MERGER OF AMERICAN REFRACTORIES INSTITUTE AND AMERICAN CERAMIC SOCIETY[1]

J. M. McKINLEY (President): We have the proposal to merge with the AMERICAN CERAMIC SOCIETY. As now constituted, the AMERICAN CERAMIC SOCIETY is a very broad carrying organization. As at present constituted they have a Refractories Division.

It was manifest to most of us that the old Refractories Manufacturers Association could never, in all probability, accomplish what it ought to for the industry. We have come to realize very clearly that the trade association functioning strictly as such eventually creates an atmosphere which precludes full development along what might be regarded as structural lines. The tendency is to bring out the selfish side of an industry rather than to develop the creative side.

The present Refractories Institute is a product of that feeling which became very general in the industry. We believe now that we are ready for the next step which was proposed at White Sulphur, which has gone through a great deal of discussion in the Board of Directors, and has finally been put in concrete form and is now to be presented for approval. The idea is, that if satisfactory in its present form today, the matter will come up for final ratification in the February General Meeting of the Institute.

There has been an inevitable conflict between the Refractories Division and the American Refractories Institute. It is only natural and proper that that condition should exist. I do not believe that the industry is large enough to afford two such bodies and there is another big fundamental reason why two such bodies should not exist in this industry. The art is in an immature state. The foundation, technically, is in many respects so lacking in real value as to preclude the possibility of these two bodies accomplishing those things they have attempted. It simply means a division of time, of thought, and of effort, which had better be put into one organization.

The proposal[2] is for the federation of the American Refractories Institute and the

[1] Quarterly Meeting, American Refractories Institute, New York City, November, 1928.

[2] For the ten points of this proposed merger see Editorial, "The Greater American Ceramic Society," *Bull. Amer. Ceram. Soc.*, **7** [12] 343–44 (1928).

AMERICAN CERAMIC SOCIETY for the promotion of the science and technology of refractories.

In brief, that is the picture approved by your Board of Directors yesterday to be submitted to you today for action. It is understood in that approval that the final work of the attorneys involved is not yet accomplished. In other words, there may be some slight change in detail, but the basic principle underlying the plan is now before you.

We should be glad to hear from Mr. Purdy on this subject, and then the matter will be opened for discussion.

R. C. PURDY: I have been asked to give a picture of the AMERICAN CERAMIC SOCIETY, what it is. There is some lack of information—I do not believe it is misunderstanding.

The AMERICAN CERAMIC SOCIETY was started some thirty-one years ago by Professor Orton, a year or two after he started the first school of ceramics in America. This was done as a tie between the industry and the university. He wanted the industrial managers and workers to have a medium for expression, and also, to help the schools. That idea has developed until today, 31 years later, we have a membership of 2600 persons and firms.

Some ten years ago the SOCIETY divided its membership into divisions, one of which is the Refractories Division, with over 500 members. The Glass Division has some 300 members, the White Ware Division over 400 members, etc. The SOCIETY is today a federation of these seven Divisions. Our Annual Meetings are seven meetings in one, each Division having its own meeting. These Divisions are self-officered and self-managed. The parent society of the AMERICAN CERAMIC SOCIETY and its executive office are the federated efforts of these seven groups. Therefore, when we speak of the AMERICAN CERAMIC SOCIETY, we are merely speaking of a federation of various groups.

The merger you have under consideration is the merger with the Refractories Division and through it with the AMERICAN CERAMIC SOCIETY. I think that is the only statement you wanted from me—a picture of the AMERICAN CERAMIC SOCIETY.

MR. LINDSAY: Is it necessary to have any special designation for members? I go to the meetings of the AMERICAN CERAMIC SOCIETY, and while my special interest is with the Refractories Division, I feel that I am a member of the whole SOCIETY. I should think that if this Institute does affiliate with the SOCIETY, that each member of the Institute would feel himself a member of the general body, and would take whatever membership in that body his classification in the Institute would entitle him to.

J. M. MCKINLEY: We were somewhat puzzled in the preparation of this matter due to the fact that both bodies are corporations. The Institute is a Class A corporation under the laws of Pennsylvania, which are rather peculiar and which limit the corporation in some respects, considerably more than is the case in the instance of the AMERICAN CERAMIC SOCIETY, which is a nonprofit corporation under the general laws of the State of Ohio. Now, inasmuch as both bodies acquire assets, and inasmuch as that is apparently a serious offense under the Pennsylvania law, we are bound to arrive at some definite distinction.

We now have the active members of the Institute, and that must be carried forward because those members are entailing obligations as well as acquiring assets. The associate membership is quite clear. Whether we can then find ourselves in a good, clear position by designating all of the remaining membership just as members, I do not know. It is a matter for the attorneys. I do not like, and no one else in the Board yesterday had very much use for, that term "Junior Associate Membership." I think it is faulty, and I am quite sure that with the general consensus of thought in the next month or so

that detail can be ironed out and a satisfactory name (if a name is used at all other than that of "member") will be found.

In answer to your point, it is only fair to say that a number of us interested in the matter, and very vitally interested, feel that that term "Junior Associate" must be taken out of there.

R. C. PURDY: Dr. Lindsay, the name he speaks of only refers to the classification in the Institute, not in the AMERICAN CERAMIC SOCIETY. There will be no distinctive classification in the AMERICAN CERAMIC SOCIETY.

J. M. MCKINLEY: That is well taken. In other words, the active members of the Institute within the corporation itself when federated with the SOCIETY, become members of the SOCIETY. Perhaps that answers your point.

S. S. COLE: Mr. President, on the matter of dues; we are associate members in the Institute and also members of the SOCIETY. There seems to be a duplication of dues through the two.

J. M. MCKINLEY: The actual structure is this: The AMERICAN CERAMIC SOCIETY ceases to have its present Refractories Division. Members now in that Division who are not members of the Institute would become members of the institute at $10.00 per year. In other words, there will be an elimination of a present duplication, and in the course of events the figures seem to indicate that there may be a slight excess of revenue to the SOCIETY after this transfer is made. That is, of course, an immaterial point. I'd be very glad to see that happen, personally.

R. C. PURDY: There would be no duplication at all.

S. S. COLE: I see the point now. Members, instead of being members of the two societies, become members of the Institute. I see the point now.

R. C. PURDY: Some of you know that the SOCIETY is a corporation that is spending about $40,000 a year. Its principal activity is promotion of education and research. One of the instruments of doing that is the *Journal*, on which considerable money is being spent. We are publishing monthly, as fully as we can obtain them, abstracts of all the literature relating to ceramics. That is averaging now about 70 printed pages a month, at a very considerable expense. The printing bill of our *Journal* alone runs from $1300.00 to $2000.00 a month.

The SOCIETY has spent all of its resources as it has gone along in the publication of the *Journal* and in the promotion of education and research. Since the establishment of the SOCIETY our ceramic schools have multiplied until there are nineteen now in the states, all of them with research facilities and resources which ought to be employed in an organized way. We promoted such an organized effort in Ohio. They are now organizing in Missouri and Illinois. Professor Shaw is accomplishing the same thing in Pennsylvania with the refractories work, and I hope he continues that until he gets the allied support for the school of all the ceramic industries of Pennsylvania. That is the only way you will be able to get the largest returns on the tax monies you are now paying in support of your state and federal research institutions. Refractories alone are not heard of so much as they would be if they were allied with the other ceramic groups. That is one of the main objectives of the SOCIETY.

The money we have spent, we think has been spent well. We are not in debt; we do not owe a cent. We have a reserve of $9700.00, and our cash on hand is just sufficient to carry us.

This merger is a natural outgrowth of the discussions we have had for several years. We are not asking it for any financial reasons. I doubt if the AMERICAN CERAMIC SOCIETY will realize a cent from this particular merger, but there is no question at all that the AMERICAN CERAMIC SOCIETY, after this group and the other groups have followed your example in this way, will be very materially strengthened, not financially,

but by power to make its voice heard in the state and federal institutions. That is what we are seeking. The AMERICAN CERAMIC SOCIETY has already been financed by you and you might as well own it. It is there for you. Thirty-one years of successful continuance is a record showing that it is something that is needed and something that can be used to your benefit.

J. M. MCKINLEY: Does anyone here know how much capital is invested in the ceramic industry of America? I just wonder if there is one of us in the room who actually knows. I am not going to answer that question for you this morning. At a later meeting I hope to answer it very fully. I find, to my astonishment, that there are no collected data on that subject. As you begin to build up the structure, the totals become very impressive, and also rather startling. But the industry is not at all conscious of either its size, its power, or its possible growth.

Our belief is that this little bit of machinery now setting up here will lead the way, as Mr. Purdy has pointed out. I'd like to have you look at the AMERICAN CERAMIC SOCIETY in this matter very much as those of us who are more or less purely business men would look at a holding company. That is what the SOCIETY is, literally in its construction, legally, and the way it ought to be actually, a holding company for other corporate bodies acquiring assets, and functioning as this Institute has and does, and we hope will in the future.

J. SPOTTS MCDOWELL: The Refractories Institute has been issuing two publications, one called *Technical Bulletins* and the other one called *Bulletins*. The technical papers are all of a quality and a proper subject matter for use in the *Journal*, but some of the *Bulletins* discuss technical matters in a very elementary way.

Those *Technical Bulletins* have proved extremely useful, and I think that there has been a very much greater demand for the elementary bulletins than there has been for the more advanced technologic papers. It seems to me quite possible that some of those very elementary bulletins would not fulfil the requirements for admission into the *Journal*, and it would be a great pity if they should be eliminated, because they have been very useful.

Another question is in connection with reprints. The Fellowship has always obtained a liberal supply of reprints of its papers, enough, in its opinion, to satisfy all demands. Very often we have not obtained enough. I think that several hundred reprints are obtained of all of the papers, and we should be very sure that with this new arrangement we still are able to get all of the reprints for use by the Institute which may be called for.

Another idea which I hope can be put into effect is that all of the papers on refractories appear together in the *Journal*, in one place. Many of our members are not interested in ceramic literature in general; they are interested only in literature on refractories. If the papers on refractories are scattered through the *Journal*, probably some of our readers will not go to the trouble of leafing through the *Journal* to find them; but if they are all in one place, that is where each person would look as soon as he received the *Journal*, and he probably will pay no attention to the other articles. It would be a very big advantage to have them all together. As one step farther than that, it would not only be an advantage to have all of the SOCIETY refractories papers and the Refractories Institute papers in that section, but it would be a decided advantage if such a thing could be arranged to have there also either reprints or abstracts of such papers as are published by the Bureau of Standards, the University of Illinois Engineering Experiment Station, and any other organizations which may be publishing literature on refractories. The present abstracts are good, but they are necessarily very brief, and if we could have some one place where all of the valuable papers on refractories would be together, it would be a decided help to all concerned.

J. M. McKINLEY: Mr. McDowell's mind is working along very practical lines. The broad answer to his question would be this: There is no loss in the actual working organization or identity of either body. The Refractories Institute would propose to continue the production of the so-called educational *Bulletin*. There will be more to say about that later. In other words, you lose no single one of your present functions in making this change but you do broaden the field under which they would operate.

I rather think that in the course of time the policy back of the *Journal* will be expanded. I hope it will be expanded to include more of the purely educational data which is greatly needed in our student bodies. I am becoming more and more impressed by the fact that we are dressing up a great deal of our technology, putting a high hat on it, and then it hasn't any place to go.

G. H. BROWN: In order to eliminate this classification of Junior membership in the Institute, a suggestion would be to divide the membership of the Institute into three classes, (1) the present active members to be known as corporate members, (2) the associate members to be known as active members, and (3) the new members or members of the Refractories Division of the AMERICAN CERAMIC SOCIETY to be classed as associate members.

J. M. McKINLEY: That suggestion is very good. The unfortunate part of it is that our charter practically shuts the door on corporate memberships legally. I am not so sure that the Federal Trade Commission and other governmental agencies wouldn't help us shut the door.

S. S. COLE: Could that be changed to "sustaining membership" instead of "corporate?"

J. M. McKINLEY: That would be a good term, and would meet your picture. We are glad to have this type of discussion, because throwing it out as we have here this morning in this form you get a very sharp reaction.

W. A. CARTER: I do not see why it is necessary that this affiliation calls for retaining the identity of the American Refractories Institute. As I gather, we are affiliating with the SOCIETY to avoid duplication and to put it on a purely technical basis. The American Society of Mechanical Engineers is constituted of several technical divisions which somewhat duplicates the organization of the AMERICAN CERAMIC SOCIETY, and as far as research is concerned, the SOCIETY appropriates a certain amount of money for research, and the industry, represented in the membership of any of these divisions by individual memberships, gets together research funds, which are turned over to the SOCIETY which acts as a sponsor for research and custodian of the funds. This may be radical, but it seems to me that we could accomplish all that I understand we want to accomplish by dissolution of the Institute, and the individual members become members of the Refractories Division of the CERAMIC SOCIETY.

As I said before, this proposed method of maintaining identity of the Refractories Institute and the Refractories Division, and talking about the various types of membership, is unnecessarily cumbersome.

J. M. McKINLEY: The American Refractories Institute has a number of off-shoots. It would seem impractical to ask an active member of a body or a sustaining member to contribute, as some of us do personally and otherwise, to the Mellon Institute work and throw that out into the control of some other organization so broad that we might lose our grasp. That fear has underlaid the insistent demand that the identity of the Institute be kept intact. In other words, it keeps that work entirely within the operation of those directly, and only those directly, interested in it.

The other feature of the fact is that the Institute, as you all know, has its business side. It just at the moment has a problem, as brought up yesterday, involving freight

rates. The CERAMIC SOCIETY is totally unqualified or disqualified by its structure to handle legitimate matters of that kind.

While I stated a moment ago that the old Refractories Manufacturers Association failed of its purpose, it was more or less a case of not meeting all of the requirements of the case. I don't want the impression to go abroad that the trade association idea is without merit, because it is. It is a very necessary thing in this generation. In other words, there must be some correlation between the technology of the industry and a purely manufacturing problem of the producer, who may or may not care about technology. As a rule, his translation is expressed in his balance sheet and in his profit and loss account at the end of the year, and he has a certain inalienable right to use spectacles colored by his balance sheet.

It seems to us that the control of an industry in all phases of its development can best be accomplished under this present plan; at least that has been the best thought so far developed, and it has been given a great deal of argument and thought.

R. C. PURDY: I'd like to say that I have given considerable study to organizations of this sort. I understand the organization of the Society of Mechanical Engineers and other organizations in our country. I testify to a belief that the present setup as proposed will give us a stronger organization, a stronger Refractories Division of the AMERICAN CERAMIC SOCIETY than anything that can be proposed. Mr. Carter's suggestion I would not say was sound; simply because that is being done by the Mechanical Engineers is no reason we can do it. We are forestalling a lot of the subsidiary or side issue organizations by this very setup that we have proposed here. I am sure that we are on the way to a greater strength by the proposal as made.

W. A. CARTER: Will this affiliation embarrass the CERAMIC SOCIETY in any way in its entity as a technical organization? The AMERICAN CERAMIC SOCIETY is purely a technical society. Would affiliation with, you might say, a trade association, or the outgrowth of it embarrass the CERAMIC SOCIETY as a technical institution?

R. C. PURDY: Not in the least. That is just the point. Your are preserving the AMERICAN CERAMIC SOCIETY as the organization in which all of the ceramic industries of the country are going to center their technical and scientific interest without in any way losing grip on their special interest in trade questions. This proposal is one of maximum strength.

J. B. SHAW: Since I have heard your outline of the plan of the proposed merger and the discussion here that has taken place, I am inclined to believe that the merger as proposed is as good as Mr. Purdy has suggested. There is no question at all but that the American Refractories Institute is a very strong, substantial, influential organization. There is no question at all about what we have accomplished. They have their place in the sun, and there are certain things which they must deal with that are foreign to what the AMERICAN CERAMIC SOCIETY has in the past, or may in the future, deal with directly. But the AMERICAN CERAMIC SOCIETY will certainly benefit very greatly from the affiliation with this organization, the American Refractories Institute, in a way that they cannot benefit should the Refractories Institute lose its identity.

On the other hand, the great benefit that has come from this merger is the elimination of the duplication of effort which is now going forward and taking place in the two organizations, the Refractories Division of the AMERICAN CERAMIC SOCIETY and the Institute. The great benefit that will be derived will be elimination of duplication of effort, by the merging of the two bodies. In many cases the members of both are the same men, but nevertheless, their efforts are duplicated as being directed from two different organizations. As far as I can see, with some of the suggestions that Mr. McDowell has made which are very good, the centralization of the publications on refractories in the SOCIETY, and I think the same thing is true with regard to other Divisions of

the SOCIETY's work, on enamel work, on glassware work, on whiteware, would be more appreciated if centralized in the *Journal*. I realize the difficulties of doing that from the standpoint of publication, but with those suggestions it seems to me the suggestions made here for the merger are all to the good.

S. M. PHELPS: I somewhat agree with Mr. Carter in that I think it is somewhat of a cumbersome arrangement according to this proposal. Basically the thing is a financial proposition, but the plan that is laid down before us seems to me to be quite cumbersome and there are a good many details that must be taken care of that are going to make up the success of the plan. For instance, we have the point brought out by Mr. McDowell on the monthly *Bulletins*. I learn now that the *Bulletins* are still to be continued. At the present time it costs us about $900 a year to send out these *Bulletins* to the members. That includes a membership of about 200. But according to the new plan there will be about 400 in addition to receive those *Bulletins*, which will more than double the cost. In addition to that, we are paying $10.00 for each member of the SOCIETY, and the members are getting in return the *Journal*.

About 90% of them will not be interested in the *Journal* except to be interested possibly in the publication of a few technical papers. The average member of the Institute, I do not believe, will leaf through the *Journal* and dig out these technical papers. Furthermore, the technical papers are not of general interest to the members of the Refractories Institute. For this reason it seems to me it would be highly desirable to have the SOCIETY take over all of the publications of the present Institute, and if possible, incorporate or send out reprints of the technical papers and the bulletins to the members of our Refractories Institute. In this way they would get only the literature they are interested in, and the bulk of the *Journal* would not be a consideration. It would be cheaper for the SOCIETY.

Furthermore, an arrangement could be made so that the technical men in the Institute, or a certain class of members, could receive the *Journal*, and in that way get all of the SOCIETY literature.

This may seem like a small point, but it is on such matters as this that the success of the merger is going to depend. As far as what we are gaining is concerned, looking at it from the viewpoint of the Refractories Institute, it seems to me the only thing we are gaining is an opportunity to receive the *Journal*, which will not interest most of the members of the present organization, and the combined meetings of the two societies. On the face of it, it seems to me there must be some more simple plan to combine these two propositions.

I do not see why the Refractories Institute has to pay $10.00 to the SOCIETY to bring this about. I'd like to hear some discussion on this question. I am in sympathy with the whole proposition, because I think it is a wonderful thing. It will be a great help to us from the technical side of the Refractories Institute. But the idea as it is now set up certainly does not appeal to me. I'd like to find out just where I am wrong in it.

J. B. SHAW: I do not understand that it will cost an extra $10.00 to belong to the SOCIETY. As I understand it, your $10.00 dues to the AMERICAN CERAMIC SOCIETY is your dues to the Institute.

S. M. PHELPS: Well the present dues of the Institute are $25.00. The refractories institute will take $10.00 out of that to pay to the SOCIETY. My point is, what is the active member getting from the SOCIETY? The same holds true with the associate member. He is not interested in the *Journal* to the extent of $10.00 reduction in the income of the Refractories Institute. It means the Institute will be paying the SOCIETY about $2000.00 a year, and the only thing we are getting is the *Journal* to the members, and I do not think the members are going to be interested in the *Journal* to that extent.

R. C. PURDY: While this calculation by your own Secretary shows $875.00 in favor

of the AMERICAN CERAMIC SOCIETY, that does not take into consideration the large number of corporation members that the AMERICAN CERAMIC SOCIETY would lose through this merger. Both organizations are going to lose some membership through financing as expressed by the present membership. But that is a trivial matter. We ought to have the large vision here instead of all these little details. The *Journal* is going to be as you want it. If you want a separate section and can support it with contributions, papers, you shall have your separate section. You already have a separate section in the abstracts. I submit that the abstracts on refractories issued each month by the AMERICAN CERAMIC SOCIETY are worth $10.00 to any member who is interested whether from a sales or manufacturing point. All those details are going to be worked out to the satisfaction and best interest of everybody concerned.

The $2000.00 just referred to is a dream. I do not know how that idea was obtained. Your Secretary figures that the Institute would be paying to the AMERICAN CERAMIC SOCIETY $875.00 more than they get from the AMERICAN CERAMIC SOCIETY. She did not take into consideration any of the losses the AMERICAN CERAMIC SOCIETY would suffer. In her report she states the figures are high. Naturally, she presented it the worst she could so you'd have no mistaken notion about this, and it was right that she did that. So instead of $2000.00 it is a much smaller figure, and even smaller than your Secretary figured out.

But that is not the point under consideration here. It is your affiliation with the glass man, the pottery man, the tile man, the terra cotta man, promoting your mutual interests that we are more concerned with. The program is very simple in its operation. As one who has studied these things, I do not see that you can find a simpler method.

S. M. PHELPS: As far as the $2000.00 goes, we have something like 200 members, I understand, of the Institute. That makes $2000.00 we are paying the SOCIETY. Our expenses for the past year in publishing the bulletins were about $900.00. We won't be saving $900.00 because we shall be publishing the bulletins. There will be that expense, and on top of that the expense of sending those bulletins to 400 additional members.

R. C. PURDY: You understand, don't you, Mr. Phelps, that practically all of your members are now members of the AMERICAN CERAMIC SOCIETY, Refractories Division, and that Division has some 500 odd members. There are about 500 from whom you are going to get $10.00.

As to your statement that you are spending $900.00 on issuing your bulletins, and that you'd double that expense by doubling the membership, you are mistaken. If you are spending $900.00 now, it won't cost you more than $100.00 more to send it to all the members, and I doubt if it would cost that much because it is only the cost of paper, a little presswork, and the postage. If you are spending $900.00 now to send to 200 members, I would undertake for a thousand dollars to send it to a thousand people.

As I understand it, the technical bulletins are to be issued by the AMERICAN CERAMIC SOCIETY.

S. M. PHELPS: That is the point that was brought out—that they are not to be.

J. M. MCKINLEY: No, Mr. Phelps, the purely technical literature will appear through the medium of the AMERICAN CERAMIC SOCIETY, but we will have, in the future, a certain amount of what I call "shoo-fly" education literature which can and should be sent out through the medium of the Institute.

S. M. PHELPS: Mr. McDowell brought out the point of the present bulletins, that they would still be sent out by the Institute.

J. M. MCKINLEY: That is an indeterminate condition. I do not see how you can anticipate that. It is a matter of good management. If such a bulletin has the necessary material in it, has the character to admit it to the Ceramic *Journal* as a per-

manent record of the art, that is where it will appear. But if, on the other hand, it is a semicommercialized bulletin or a purely educational brief for the benefit of the student mind, both adult and adolescent, from the graduate from college standpoint, or from the brickyard standpoint, then that sort of thing can and will be paid for by the Institute itself.

I think perhaps we might get lost here in our minds on this point, because after it is all said and done, whether the CERAMIC SOCIETY has 5 members now or 500, and whether we have 2 or 200 is immaterial. The fact of the matter is that the Refractories Institute is footing that bill as a whole. There is no corporation represented in this room that does not have membership on both sides. When that shuffle takes place, I am not prepared to tell you how it will all come out, and incidentally, I am not worried about it.

I do not want to endeavor to sell this thing from the Chair, because that is bad business, and I hope you won't feel that I am guilty of that. I am very much interested in this because I think it is a big step toward the future both constructively and in detail. The detail is totally within our own hands.

The question of this plan being cumbersome occurred to Mr. Carter and Mr. Phelps instantly. No doubt other minds have approached it in the same way. I am sorry that that had to be in that particular form, but when you set out to maintain an underlying body such as this Institute, and keep it intact so that it may function in various ways, and then federate it or nationalize its character, you are confronted with a purely legal problem. In other words, this preamble here had to be rewritten after its first draft because the legal structure was faulty. In fact, that happened as late as last night, showing that it is not altogether as mechanically simple as it might seem on the surface. I will warrant the assertion, in closing these remarks, that within three months or a year after this federation takes place, you will have forgotten entirely the fact that two corporations exist, because you will be functioning as one body. In other words, you lost sight of that phase of the thing very quickly.

I do not know whether that answers that problem in your mind or not. It is just a mechanical one.

S. M. PHELPS: The outline as we have it now does seem cumbersome, and it is that you are putting up before the members. We ought to have more discussion before we act on it. It is these details that are going to make or break the proposition.

As I said in the beginning, I, personally, am greatly in favor of the whole proposition, but I do not agree with the details, with the arrangement as it is laid down at the present time. To the technical men of the present Institute it is a vital proposition. I think that they should be given due opportunity to consider it before the final move.

J. M. MCKINLEY: The present technical work that is in the Institute can't help but be benefited, because it will remove entirely any avenue through which interference could occur. In other words, the present Technical Advisory Committee of the Institute would become the sole working committee of the industry. There would be no opportunity whatsoever for interference. Again the element of management comes in. If that committee is badly managed, then you could expect most anything out of this. It is a good deal like getting married—you simply have got to take some chance!

Mr. Kier is Chairman of the Mellon Institute Committee, and I am glad he is on the floor.

S. M. KIER: The only thing I want to talk about is the *Bulletin* proposition. We are committed to get out a monthly *Bulletin* from the technical division. You state some of them may go through the *Journal* and some may not. Mr. Purdy, how do you decide what bulletins you are going to publish in your ceramic magazine?

R. C. PURDY: I can only tell you what we are doing at present. All papers are

submitted to the Committee on Publications. The papers come to me. I send them to the Chairman of that Committee. We have published practically all papers that have come in.

S. M. KIER: You publish them and make reprints if necessary?

R. C. PURDY: Reprints are made on order. Each author gets fifty reprints free and in the case of the Mellon Institute, the Bureau of Standards, and other institutions of that sort, they get 200 reprints free. That has been our policy.

S. M. KIER: That is what I want to come to now. We shall assume we have 400 or 500 members in this new organization. You get out this monthly *Bulletin*. Suppose we send it to you; you agree to send us enough reprints each month. Then your publication theoretically, or otherwise, can decide whether they want to put it in the *Journal* or not. That does not interest us. We want to be sure to get those every month. We do not want to duplicate this, send it to you to publish it, and then, if not, we are going to publish it.

R. C. PURDY: I have seen all your Institute *Bulletins*, and I have not seen a publication from the American Refractories Institute that would not be published either in the *Journal* or the *Bulletin* section of the AMERICAN CERAMIC SOCIETY.

S. M. KIER: We will send you our monthly *Bulletin*, and you agree to reprint it for our membership. If you want to use it further than that, it is up to you.

R. C. PURDY: That is the agreement now set up.

S. M. KIER: That clears it up for you, does it not, Mr. Phelps?

S. M. PHELPS: Yes.

S. M. KIER: Whether you print it in the *Journal* or not, we will get that in a reprint.

R. C. PURDY: It will be published in the *Journal*, and reprints will immediately be sent you.

S. M. KIER: How late will that be in the month?

R. C. PURDY: It takes our printer about three weeks after the *Journal* is out to run off these reprints and get them out.

S. M. KIER: Is that all right?

S. M. PHELPS: It suits me. The only thing is this: You know what our monthly *Bulletins* are. They are not technical. We take a subject and write it up in an elementary way for the members of our organization, get it across to them. You wouldn't want to put that in your *Journal*, would you?

R. C. PURDY: We have a section in our publication called the *Bulletin* designed for that purpose. We have not been using the *Bulletin* of late as it was intended simply because we have had a much larger abstract section than we anticipated. Our abstracts now have gone about thirty pages per month more than we anticipated. Therefore, we have reduced our *Bulletin* to save money in order to publish these abstracts, they being more important. But our *Bulletin* section is designed for just such papers as the A.R.I. *Bulletins*.

S. M. PHELPS: Then we could get those reprints. Could we get reprints of any technical papers we sent to you for?

R. C. PURDY: You have always had them.

S. M. PHELPS: That could be worked into this plan. We can mail them to our members. That is just the point I want to bring out.

S. M. KIER: I'd like to make one suggestion here. This proposal yesterday was put before the Board of Directors and approved subject to some minor changes made on legal points and a few other arrangements which were to be brought back to the next meeting and those changes passed on. I think these minor details just like this *Bulletin* thing, the dues, etc., can be worked out between the two of us to a mutual advantage.

I just wanted to let you know what the *Bulletin* was and what the suggestion was. There will be some minor changes, no doubt.

J. M. McKINLEY: You are not ratifying an agreement here this morning. The active member of the Institute is the only individual qualified to vote on this proposition. He is not asked to commit himself to this plan this morning. As a corporation, this matter comes before the active member for his approval. Legally, that is a tentative action, and any motion to approve carries with it either the direct or the implied provision that the matter must go through the proper legal clearance, the details must be adjusted, and the plan come back in February for ratification. You are not passing on this finally here today in any sense of the word at all. This is merely your warning that in February you will be asked, if the matter progresses satisfactorily, to ratify an action which you take here today. If you fail to ratify it, the thing is dead, that is all.

R. C. PURDY: In that connection, Mr. Chairman, I would say that this matter, of course, has got to be put before the AMERICAN CERAMIC SOCIETY. There are two parties to the agreement. That has not yet been presented to the AMERICAN CERAMIC SOCIETY. It is up to the members of the Board of Trustees and the officers of the Refractories Division. All of the Board have approved the general idea and it awaits a joint committee to work out the details. All the officers and chairmen of committees of the Refractories Division save one have approved that, and that one has been heard from on the floor of the meeting today.

W. A. CARTER: I'd like to ask when this proposal is circulated to the active members of the Institute for approval later, if the associate members may have copies of it too, with the understanding, of course, that they are not voting. I think it is of interest to the associate members as well as the active members.

J. M. McKINLEY: We will go a step further than that. The entire membership of both bodies should be completely advised of the final form and detail of this. We do not intend to split hairs on that. We shall send out something that you will read. If we went down into the last basic bit of detail the chances are we'd send you a book that nobody would read, but we have already the plan laid down to fully acquaint everybody with the detail because after all is said and done, while under our By-laws only active members vote, the fact remains that this isn't worth very much without the entire coöperation of everybody.

S. M. KIER: I move the general approval of the plan of the federation of the two organizations at this meeting subject to the transcripts of the suggestions here, that it be put before the committes of the two organizations to draft up a plan to be presented to the next meeting for ratification.

The motion was duly seconded.

J. M. McKINLEY: You have heard the motion. Is there any discussion?

S. M. KIER: I'd like to add to that motion that the general plan be sent to all the members of the American Refractories Institute, both active and associate.

Agreeable to seconder.

J. M. McKINLEY: Is there any further discussion?

There being no further discussion the motion was put and carried unanimously.

NEW MEMBERS RECEIVED FROM NOVEMBER 1 TO DECEMBER 1

CORPORATION

Rickmann & Rappe Chemical Company, G.m.b.H., Koln-Kalk, Germany, E. Rickmann, representative.

PERSONAL

Walter Boswell, 624 Alta Ave., Santa Monica, Calif., General Manager, Alhambra Kilns, Inc., Alhambra, Calif.

Oscar Byron, 33 West 42nd St., New York City, Sales and Development Engr., Nichols Products Corp.

D. W. Graham, 667 S. Ardmore Ave., Los Angeles, Calif., Chemist for Washington Iron Works.

Walter S. Mayer, Mayer China Co., Beaver Falls, Pa.

Joshua L. Miner, 814 Second Place, Plainfield, N. J., Technical Manager for Atlas Lumnite Cement Co.

Mabel Ballou Nestler, Bell Island, South Norwalk, Conn.

Paul F. Siegrist, 267 W. Franklin St., White Hall, Ill., Ceramic Engineer for White Hall Sewer Pipe & Stoneware Co., White Hall, Ill.

Sydney Way Vickery, 151 Hinton Ave., Ottawa, Ont., Canada, Enameling Superintendent of Beach Foundry, Ltd.

James Edward Walsh, Montmagny, Quebec, Canada, Enamel Superintendent for A. Belanger, Ltd., Stoves, Montmagny, Quebec, Canada.

Edmondson Warrin, 43–45 W. 13th St., New York City, President of Edmondson Warrin, Inc., New York City.

STUDENTS

Arthur D. Drake, Ohio State University, Columbus, Ohio.

Harold Karthauser, N. Y. School of Clay Working and Ceramics, Alfred, N. Y.

Roscoe Keller, N. Y. School of Clay Working and Ceramics, Alfred, N. Y.

Don C. Lynn, N. Y. School of Clay Working and Ceramics, Alfred, N. Y.

J. C. Mays, N. Y. School of Clay Working and Ceramics, Alfred, N. Y.

Herbert T. Meyer, N. Carolina State College, Raleigh, N. C.

H. Zane Schofield, Ohio State University, Columbus, Ohio.

Membership Workers' Record

	CORPORATION	PERSONAL	STUDENT	
P. H. Bates		1		
Charles F. Geiger		1		
A. F. Greaves-Walker			1	
Jane Hoagland		1		
R. B. Keeler		1		
A. Malinovszky		1		
W. Mavor		2		
F. Westendick			4	
Office	1	3	2	
	1	10	7	Total 18

HERBERT BARR HENDERSON

Candidate for Treasurer

H. B. Henderson, or "Doc" as he is known to his intimates, comes from the hills of Harrison County, Ohio, having been born at Scio, on November 22, 1873. He grew up on a farm, as so many of our leaders have done, taught country school awhile to clinch and consolidate what he had learned in passing through the little red schoolhouse, and in 1898 presented himself for matriculation at the Ohio State University where he entered a four-year course in Pharmaceutical Chemistry taking his degree (B.S.) in 1904. This was a much heavier and stronger course than is given to Pharmacists in general, and equipped him so well on general analytical and industrial chemistry that he has used that subject as his mode of approach to his life work, instead of the pharmacy.

His first job after graduation was with the Hance Brown Casting Company of Columbus, where he acted as superintendent. He left their employ in 1906 to enter the

employ of Professor Edward Orton, Jr., as assistant superintendent of the Standard Pyrometric Cone Company under L. B. Coulter, deceased. In 1908, when Coulter went as ceramic engineer to the Carborundum Company, Dr. Henderson became superintendent of the Cone Company and has continued in that capacity ever since.

His knowledge of silicate chemistry was broadened by taking some of the courses in ceramics at the University and by using his knowledge constantly in making a product of rigidly uniform fusing behavior and dependable quality, from mineral materials which are subject to the variations in composition and physical character that goes with all natural mineral deposits. Also, in explaining the troubles which beset the firing of ceramic products of all kinds, and in advising cone users as to the cause and cure of such troubles, he has had a large and varied industrial experience and has gained a rare insight into this difficult field.

As evidence of the breadth of his knowledge and the wide distribution of his scientific interests, the following list of his publications will be enlightening:

"Tests of Assay Crucibles." (Co-Author with Edward Orton, Jr.)
"Use of Pyrometric Cones."
"Effect of Rate of Application of Heat to Clays and Clay Bodies."
"Utilization of Ohio Clay Bonded Sandstone for Silica Brick." (Co-Author with W. Stout.)
"Some Phenomena in Glaze Reduction."
"Increase in Refractoriness in Ceramic Bodies in Interrupted Heat Treatment." (Co-Author with J. H. Caldwell.)

These papers have all been prepared and the researches conducted as extra work in addition to his heavy daily responsibilities in the Cone Company, which is the best proof of his interest in scientific and technical work and his devotion to the AMERICAN CERAMIC SOCIETY, which he has served as Treasurer for four years.

LOCAL SECTION NEWS

Baltimore-Washington Section

At the November 24 meeting of the Baltimore-Washington Section held in Baltimore, Md., officers for the year were elected.

R. A. Heindl, *Chairman*
H. C. Weiskittel, Jr., *Vice-Chairman*
E. C. Greenstreet, *Secy. and Treas.*
H. Insley, *Councillor*
J. W. McBurney, *Chairman, Program Committee*

Papers were presented by J. H. Ferguson on "Application of Pyrometer and Temperature Control Equipment in the Ceramic Industries" and by Richard Turk on "Cast Iron for Enameling." C. B. Garwood, general superintendent of the Carr-Lowrey Glass Co., talked of his experiences in England last summer with the ceramists.

Plans were discussed whereby this Section can assist in the entertainment of the British ceramists next spring.

Those attending this meeting were:

Anthony J. Dietz, Franz Novak, Richard Turk, Porcelain Enamel & Mfg. Co.
Phillip Heuisler, W. Ronald Lester, L. C. Roche, Maryland Glass Corp.
A. C. Cameron, the North East Fire Brick Co.
B. T. Sweely, R. R. Fusselbaugh, H. E. Engliter, E. C. Greenstreet, Baltimore Enamel and Novelty Co.
R. R. Barr, Standard Gas Equipment Corp.
H. C. Weiskittel, A. Weiskittel Co.
A. B. Christopher, Northeast, Md.

R. M. Balmert, Baltimore Copper Smelting & Refining Co.
W. A. Weldon, Locke Insulator Corp.
H. Lee Hoffman, *American Enameler*
C. B. Garwood, George O. Smith, and C. B. McComas, Carr Lowrey Glass Co.
R. A. Blunt, Buch Glass Co.
H. P. Rodgers, Brown Instrument Co.
J. H. Ferguson, The Bristol Co.
Karl Langenbeck, Washington, D. C.
L. E. Mong, R. A. Heindl, D. H. Fuller, Herbert Insley, J. F. Klekotka, and A. Q. Tool, U. S. Bureau of Standards, Washington, D. C.

Pittsburgh Section

One of the most successful meetings in the history of the Pittsburgh Section was held on December 8 at New Castle, Pa. The Universal Sanitary Mfg. Co., the New Castle Refractories Co., and Shenango Potteries were visited in the afternoon. George A. Bole of the Ohio State Experimental Clay Products Plant gave an address on the need of various types of research in the ceramic industries and applying the results of this research to plant practice.

Officers for the year were elected as follows:

W. Keith McAfee, *Chairman*
P. D. Helser, *Vice-Chairman*
R. F. Ferguson, *Secretary*
S. M. Swain, *Treasurer*

This Section claims to be the livest and most active in the country. It is hoped that as many as possible of the members of this district will avail themselves of the opportunity for good fellowship and corridor sessions which precede and follow each monthly meeting. Associates may join this section without belonging to the parent Society.

The following men attended this meeting:

L. A. Vincent, American Dressler Tunnel Kilns, Inc.
R. A. Horning, Armstrong Cork Co.
H. Bacharach, J. A. Stein, L. J. Speidel, B. Thiede, L. S. Vaya, Bacharach Industrial Instrument Co.
J. Ross Buchanan, Beaver, Pa.
G. R. Owens, Bristol Co.
Wm. E. Rice, Bureau of Mines
R. E. Stark, Crown Chemical Co.
Geo. E. Buxton, B. F. Drakenfeld Co.
Geo. E. Crawford, P. D. Helser, Eljer Company
M. A. Piatt, Donald W. Ross, Findlay Clay Pot Co.
W. J. Hocking, R. T. Hall, Norman Heath, W. F. Smith, Hall China Co.
Robert Boyce, Harker Pottery Co.
W. E. Daugherty, George M. Frauens, O. Hommel Co.
D. K. Ballard, P. S. Kier, B. E. Whitesell, Kier Fire Brick Co.
H. K. Burson, J. W. Hepplewhite, Edwin M. Knowles China Co.
Sandford S. Cole, Koppers Co.
Harold E. White, Lava Crucible Co.
J. H. Blewett, J. A. Martz, McLain Fire Brick Co.
E. J. Casselman, R. F. Ferguson, G. K. Lowe, Mellon Institute
J. V. Bowman, Gordon Klein, H. S. Kirk, R. M. Russell, L. Richardi, C. E. Turner, New Castle, Pa.
R. E. Whittaker, New Castle Refractories Co.
G. A. Bole, Ohio State University
H. B. DuBois Pennsylvania Pulverizing Co.
F. B. Jones, D. W. Loomis, H. K. Mitra, R. E. Polk, Samuel Porter, Pittsburgh, Pa.
Dewitt D. Irwin, Wm. W. Irvin, Potters Supply Co.
S. R. Lee, Rust Engineering Co.
Thomas A. Sant, Thomas A. Sant & Son

Fig. 1.—Members of Pittsburgh Section at New Castle, Pa.

P. A. Smith, A. F. Smith Co.
M. R. Hornung, J. M. Smith, Shenango Potteries
R. C. Boyd, D. R. Johnston, R. J. Paddock, Erwin Sohn, Drury D. Turner, Standard Sanitary Mfg. Co.
S. L. Barnes, Ed. Bixler, Clare W. Fischer, F. A. Glenn, W. Keith McAfee, Wm. Osler, Richard E. Reif, C. M. Whittaker, G. W. Whitaker, University Sanitary Mfg. Co.

California Section

The December meeting of the California Section was held at the Engineers' Club, Los Angeles, on the tenth of the month.

After the dinner Mr. Heiman of the Pacific Clay Products and Earl Dundas of the Gladding, McBean and Company presented papers on "The Allocation of Costs." A moving picture of Celite Products Company's plant at Lompoc, Calif., was shown. Dr. O. B. Westmont of the Celite Products Company gave an illustrated talk on "Thermal Conductivity."

Election of officers for the coming year was held. Those elected were:

C. J. Biddle, *Chairman*
A. L. Gladding, James W. Moncrieff } *Vice-Chairmen*
I. B. Branham, *Secretary*
Elmer H. Ockerman, *Treasurer*
Wm. McClintock, Wm. Phillips } *Executive Committee*

NOTES AND NEWS

NEWS FROM THE CERAMIC SCHOOLS

Ohio State University [1]

E. P. Ogden, consulting ceramic engineer of Columbus, Ohio, delivered an address to the Student Branch, December 12, at Lord Hall, on "The Manufacture and Uses of Special Refractories." He covered the fields of silica, magnesite, and chrome bricks, and other refractory shapes.

G. G. Bernard was elected secretary and treasurer of the Student Branch of the SOCIETY.

"Glass Tank Refractories and Their Chemical Relationship with Molten Glass," by Kai-Ching Lu, of the Ceramic department at the Ohio State University (1927–28) and now with the Research Division, U. S. Gypsum Co., Chicago, Illinois, is now available for distribution by the Engineering Experiment Station at the Ohio State University. Price 50 cents.

Of the twenty-three students elected to Tau Beta Pi, National Honorary Engineering Fraternity, three were ceramic engineers, Gerald W. Hofstetter, Donovan J. Rice, and Walter C. Rueckel.

The ceramic department at Ohio State University has launched an extensive program of expansion and revision. This program when complete will make the ceramic

[1] E. P. Czolgos, *Corresponding Secy.*

engineering curricula modernized to date and the ceramic engineering laboratories among the best in the world.

The present ceramic engineering curricula has been revised and a new ceramic engineering curricula will be offered in 1929. New courses are to be added to the present curricula, and students will be given opportunity to take more elective work. The new courses that will be given are as follows:

Ceramic Engineering 600, Theory of Drying
" " 601, Changed to Driers, Kilns and Theory of Firing
" " 603, Elements of Ceramic Plant Design
" " 708, Glass Technology
" " 721, Laboratory Work in Refractories
" " 722, Laboratory Work in Heavy Clay Wares
Advanced English 419
15 hours of electives.

New equipment is being installed in the ceramic laboratories and the present equipment is being remodeled in preparation for the new courses that are to be given and for the purpose of carrying out more intensive, accurate, and extensive laboratory and research work.

The kiln department has been remodeled with three large experimental kilns, a new load furnace for testing refractories under load at elevated temperatures, a muffle kiln for firing terra cotta and pottery, and small furnaces for testing refractories and melting glasses and enamels.

This is part of the extensive program of expansion that is being launched by the ceramic department at Ohio State University.

Ceramic Short Course at O.S.U.

This course held on December 3 to 8, 1928, was attended by fifty representatives of the ceramic industry of whom twenty-seven were from Ohio, six from Pennsylvania, five from Missouri, three from Kentucky, two from Indiana and one each from California, Illinois, Kansas, Michigan, Nebraska, New Jersey, and New York.

The open discussions were limited to problems in connection with control of processes and products in the heavy clay, refractories, and metal enamel industries. The whiteware and artware sections were abandoned early in the week due to very light registration caused by the meeting of the U. S. Potters Conference the same week.

The division of attendance in the three sections held was as follows:

Heavy clay	28
Refractories	17
Enamels	5

The general sessions at which all were present were limited to the opening session the afternoon of December 3, when apparatus was discussed and manufacturers of kiln and drier control apparatus presented their equipment and followed with demonstrations in the Kiln Department of the University. This was a great success, and a very valuable contribution to the success of the course.

On Friday evening, December 7, the Short Course attendance, instructors, and counselors assembled for a banquet on the campus and were addressed by J. L. Murphy, past president of the Ohio Ceramic Industries Association, M. C. Booze, President, AMERICAN CERAMIC SOCIETY, and G. A. Bole, Ceramic Research Professor, Ohio State University. The system of open discussions and free presentation of problems, introduced in this course, by all who attended was declared a pronounced success.

Iowa State College
Short Course for Clayworkers

January 9, 10, 11, 12, 1929

WEDNESDAY

9:00 A.M. Registration and Inspection Trip.
2:00 P.M. "Abrasive Wheels," Paul E. Cox, Head Ceramic Eng. Dept. (motion pictures)

THURSDAY

9:00 A.M. "Scum and Efflorescence," D. A. Moulton, Ceramic Eng. Dept.
10:00 A.M. "Reading of Blue Prints," E. C. Flynn, Ind. Arts Dept.
11:00 A.M. Discussions.
1:00 P.M. "Refractories," D. A. Moulton, Ceramic Eng. Dept.
2:00 P.M. "Care of Electrical Machinery," G. I. Mitchell, Ind. Arts Dept.
3:00 P.M. "Wall and Floor Tile," K. D. Gould, Ceramic Eng. Dept.

FRIDAY

9:00 A.M. "Manufacture of Electrical Porcelain" (motion pictures).
10:00 A.M. "Burning Pulverized Fuel," D. J. Watson, Ceramic Eng. Dept.
11:00 A.M. Discussion on "Burning."
1:00 P.M. "Use of Hollow Building Tile in Farm Buildings," Henry Giese, Agr. Eng. Dept.
2:00 P.M. "Modernizing Plant Driers," D. A. Moulton, Ceramic Eng. Dept.
3.00 P.M. Discussions.

SATURDAY

9:00 A.M. "Explosives" (motion pictures).
10:00 A.M. "Foremanship," E. S. Baird, Eng. Expt. Service.
11:00 A.M. "Strength of Hollow Tile Walls," J. H. Griffith, Civil Eng. Dept.

There are no fees in connection with this course. Anyone interested in the manufacture of clay products is invited to attend.

CUSHMAN FELLOWSHIP AWARDED

R. C. Bryant has been awarded the Cushman Fellowship for 1928–29 at Western Reserve University, Cleveland, Ohio. This Fellowship was established several years ago by H. D. Cushman, President of The Ferro Enameling Company, Cleveland, Ohio, and is for the investigation of problems connected with the process of porcelain enameling. Mr. Bryant is a graduate of Western Reserve University.

BINNS MEDAL TO FRANK GRAHAM HOLMES

Frank Graham Holmes, art director and designer of Lenox, Inc., has been selected as the recipient of the Binns Medal for 1928. There will be no public presentation of the medal this year. Marion Lawrence Fosdick in 1926 and Arthur Baggs in 1927 have received the Binns medal.

OTHER CERAMIC MEETINGS

St. Louis Enamelers' Club

At the November Meeting of the St. Louis District Enamelers' Club, held in Belleville, Ill., Nov. 27, 1928, Frederick S. Markert, Chief Engineer, The Ferro Enamel Supply Company, Cleveland, spoke on "The History and Development of Continuous Furnaces for Porcelain Enameling." The talk was illustrated by a motion picture film showing the Manion Single-End type Continuous Furnace which is in operation at The Canton Stamping and Enameling Company, Canton, Ohio.

NEW JERSEY CLAY WORKERS ASSOCIATION ANNUAL MEETING

The Annual Meeting of the New Jersey Clay Workers Association was held at Rutgers University, New Brunswick, N. J., on Dec. 19, 1928.

The following program was presented:

Business Session.
Address by the President, E. V. Eskesen, Federal Seaboard Terra Cotta Corporation.
"Factors Influencing the Properties of Dust-Pressed Wares," E. C. Henry, Dept. of Ceramics, Rutgers Univ., New Brunswick, N. J.
Installation of New Officers.
Observations on the Ceramics Industry in Europe, by G. H. Brown, Fred Sutterlin, and George Simcoe.
Final Business Session.

CALENDAR OF CONVENTIONS

Organization	Date	Place
AMERICAN CERAMIC SOCIETY		
(Annual Meeting)	Feb. 4–9, 1929	Chicago, Ill.
(Pittsburgh Section)	Jan. 8, 1929	Pittsburgh, Pa.
American Concrete Institute		
(Annual Meeting)	Feb. 12–14, 1929	Detroit, Mich.
American Face Brick Assn.	Feb. 4–9, 1929	Chicago, Ill.
American Refractories Institute	Feb. 4–9, 1929	Chicago, Ill.
American Zinc Institute	April 15–17, 1929	St. Louis, Mo.
Assn. of Scientific Apparatus		
Makers of America	May 3, 1929	Los Angeles, Calif.
Common Brick Mfrs. Assn.	Feb. 4–9, 1929	Chicago, Ill.
Hollow Building Tile Assn.	Feb. 4–9, 1929	Chicago, Ill.
Natl. Assn. of Mfrs. of Heating and		
Cooking Appliances	May 8–9, 1929	New York City
Natl. Brick Mfrs. Assn.	Feb. 4–9, 1929	Chicago, Ill.
Natl. Paving Brick Mfrs. Assn.	Feb. 13–15, 1929	Washington, D. C.

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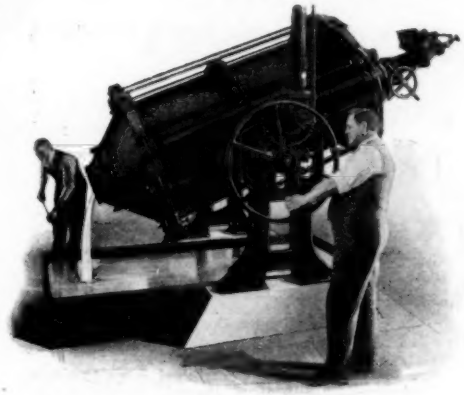

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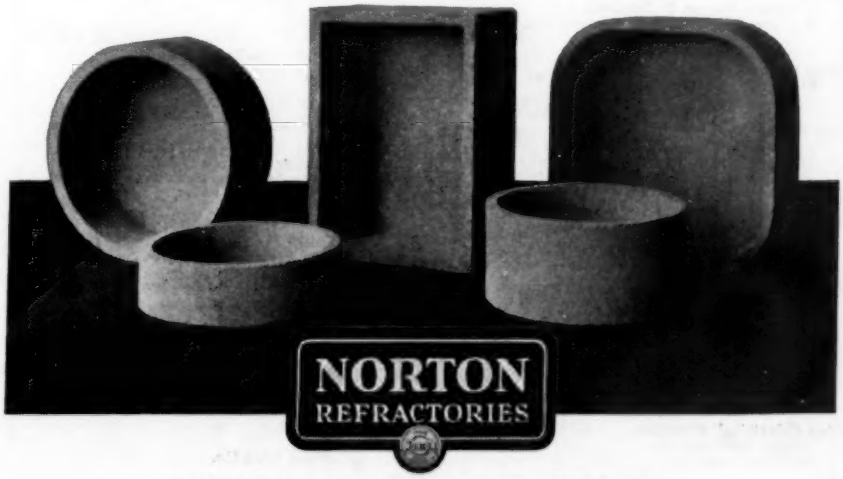

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Harshaw Fuller & Goodwin Co.
Roessler and Hasslacher Chemical Co.
United Clay Mines Corp.

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Harshaw Fuller & Goodwin Co.
Kentucky-Tennessee Clay Co.
Spinks Clay Co., H. C.
United Clay Mines Corp.

Clay (Enamel)
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Golding Sons Co.
Harshaw Fuller & Goodwin Co.
Kentucky-Tennessee Clay Co.
Metal & Thermit Corp.
Roessler & Hasslacher Chemical Co.
United Clay Mines Corp.
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D

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Drying Machinery
Philadelphia Drying Machinery Co.
Proctor & Schwartz, Inc.

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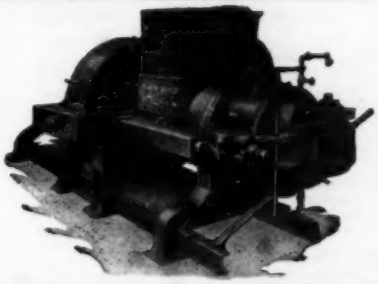

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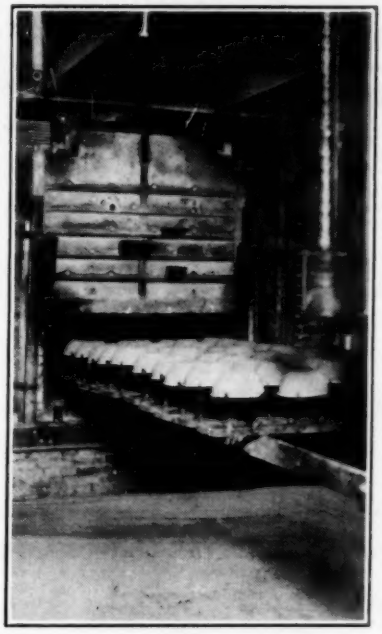

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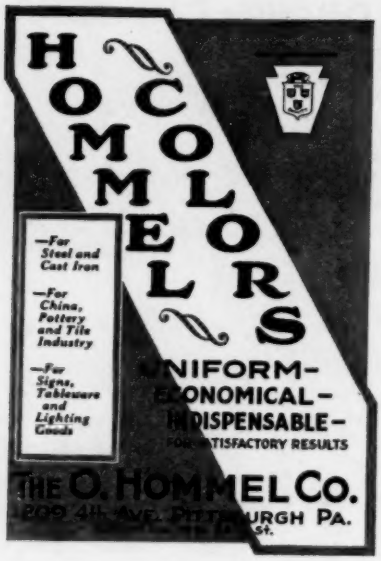

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